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ALEURIA AURANTIA

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(WITH COLORED ILLUSTRATION)

Commonly known by the name *Peziza aurantia* this is one of larger as well as one of the most attractive of the operculate cup-fungi. Unfortunately, the color does not persist long on drying or when preserved, and it then becomes necessary to rely on other characters in diagnosing the species. Nature has been very considerate and provides us with another character less easily observed, but no less definite and dependable. The spores when mature are covered over with a coarse net-work of ridges giving them a reticulate surface. It is this character which has been used in segregating the genus *Aleuria* of which this species is the type.

The plants of this species occur throughout temperate North America, and may occur singly and regular in form or they may give rise to congested masses, the individuals becoming much contorted and twisted. McIlvaine states: "At Mt. Gretna, Pa. patches of it twenty feet long made the ground along a road on the margin of a woods golden with its clusters." It grows usually on bare ground and often on clay banks and may be found from May until late autumn.

While the writer has not used this fungus as food, McIlvaine claims to have eaten it for fifteen years. At any rate like most of the cup-fungi it is not poisonous and can be eaten with impunity.

For a complete description and synonymy see North American Cup-fungi, page 97.

THE NEW YORK BOTANICAL GARDEN

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STUDIES ON FILM-FORMING YEASTS. ACID PRODUCTION BY ZYGOPICHIA AND ZYGOHANSENULA [1]

WALTER J. NICKERSON

(WITH 4 FIGURES)

Film-forming yeasts are of widespread occurrence and of considerable economic importance. Representatives belong to the sporogenous genera *Pichia*, *Zygopichia*, *Hansenula*, *Zygohansenula*, and *Debaryomyces;* and to the asporogenous genus *Mycoderma*. They are frequently found growing on salt brines used for the storage of various food products; Mrak and Bonar (**1939**) in a study of the taxonomy and salt tolerance of certain film yeasts include a good bibliography. Fermented beverages of many types have yielded new forms. In some cases a particular quality of the drink has been attributed to these yeasts (*e.g.*, the "flor" of sherry, *cf.* Hohl and Cruess, **1939**) while in other cases they have been looked upon as nuisances because of their ability to oxidize ethanol rapidly or to impart "off-flavors." Danzig beer, English cider, native African wine, and Mexican pulque are but a few of the aqueous habitats. Ruiz Oronoz (**1936**) isolated *Zygopichia farinosa* from the exudate of ash trees in Mexico.

In connection with taxonomic work (**1944**) on the genus *Zygosaccharomyces*, wherein it was found advisable to transfer certain misplaced film-forming species to *Zygopichia*, the author became interested in the close relationship between the genera *Pichia* and *Hansenula*. Mrak, Phaff, Vaughn, and Hansen (**1942**) have pointed out that only the ability to utilize nitrate now separates the two genera and they believe it may become necessary to combine the two genera. (*Zygopichia* and *Zygohansenula*, along with *Zygosaccharomyces*, occupy the rank of subspecies in Stelling-Dekker's (**1931**) system, each being separated from the parent

[1] Grateful acknowledgment is made of aid by a grant from the Cyrus M. Warren Fund of the American Academy of Arts and Sciences, and by a grant from the Faculty Research Fund of Wheaton College.

species by having gametic conjugation preceding spore formation.) The discovery of new species of *Pichia* and of *Hansenula* has been responsible for so broadening each of the generic limits that today there is considerable overlap on all points except that of nitrate utilization, which is negative with *Pichia* and positive with *Hansenula*.

Since yeasts apparently must reduce nitrate before utilizing it, species of *Pichia* should give a negative test for the presence of nitrite, a reduction product of nitrate, in the culture medium. However, if nitrate is to be reduced, a suitable hydrogen donor must be present. Ordinarily in tests for nitrate utilization (auxanograph) or for nitrite (*cf.* Manual of Methods, **1942**) glucose is the hydrogen donor; yet it is possible for some organisms (species of *Pseudomonas* for instance) to reduce nitrate with a suitable hydrogen donor but not with glucose, that is the requisite dehydrogenase is not present or developed. While one could test all of the many substances that are suitable carbon sources for *Pichia* growth in an attempt to find a suitable hydrogen donor for nitrate reduction (if successful, decreasing again the distance between the two genera), only ethanol and glycerin were studied.

Some of the aspects of acid production by various species of *Zygopichia* and *Zygohansenula* were examined. The physiology of acid production by yeasts is not very well understood and, with a few exceptions, little work has been done on the metabolism of film-forming species.

CULTURES USED

Zygopichia Chevalieri (Guilliermond) Klöcker.

Culture M 1, kindly supplied by Dr. E. M. Mrak.

Culture H 175, kindly supplied by Dr. D. H. Linder; this strain originally No. 617 from Guilliermond's laboratory.

Zygopichia farinosa (Lindner) Klöcker.

Culture No. 2252 from the Am. Type Culture Collection.

Zygopichia Chevalieri var. *Andersonii* Nickerson (syn. *Zygosaccharomyces bisporus* Anderson).

Culture H 177, kindly supplied by Dr. D. H. Linder; this strain originally No. 569 from Guilliermond's laboratory.

Zygohansenula californica Lodder.
Culture from Dr. Mrak as No. 111.

Hansenula saturna (Klocker) Sydow.
Culture H 85, supplied by Dr. Linder.

Hansenula anomala (Hansen) Sydow.
Culture H 86, supplied by Dr. Linder.

Pichia membranefaciens Hansen.
Culture from Am. Type Culture Coll.

METHODS

Two day old growths of these yeasts on wort agar (Difco) plates were used to seed the various media employed; the plates were scraped and the cells suspended in sterile M/15 KH_2PO_4 buffer to a standard photometric density. The experimental culture media consisted of a basal medium with various amendments; composition of the basal medium was as follows: 3.0 g. KH_2PO_4, 3.0 g. $(NH_4)_2SO_4$, 0.25 g. $MgSO_4$, 0.25 g. $CaCl_2$, 2.0 g. Bacto-peptone, 0.10 g. yeast extract, and distilled water to make one liter. Amendments included glucose and ethanol; recently boiled 95 per cent ethanol was added aseptically to sterile flasks of the basal medium to give the requisite final concentrations; glucose solutions were autoclaved separately and added to the basal medium to give the requisite final concentrations. Fifty cc. Erlenmeyer flasks containing 25 cc. of media were inoculated, incubated at 25° C. and the contents analyzed after seven days.

Total acidity was determined by titrating, after heating, a clear centrifugate of the medium with 0.100N NaOH, using phenolphthalein as indicator. Growth measurements were made using a photoelectric densitometer constructed [2] after the design of Stier, Arnold, and Stannard (**1934**). Sugar remaining in the medium was determined by Benedict's (**1931**) method. All

[2] The author wishes to express his thanks to Dr. Glenn A. Shook, Professor of Physics, Wheaton College, for his invaluable aid in construction of this apparatus. The method of Stier, Arnold, and Stannard was simplified by the use of Photronic cells thus eliminating the 90 volt battery. Computation was practically eliminated by making the resistance R_2 1000 ohms when sterile media was in the tube; balance being made with R_1. When a suspension was in the tube balance was made with R_2, R_1 remaining constant.

analyses were made in triplicate on duplicate flasks; since the individual determinations were in good agreement, only averages are presented.

ACID PRODUCTION

ETHANOL SERIES.

Three yeasts were used: *Zygopichia Chevalieri* var. *Andersonii*, *Z. Chevalieri* (M 1), and *Zygohansenula californica*. As will be seen in figure 1 acid production by the two varieties of *Zygo-*

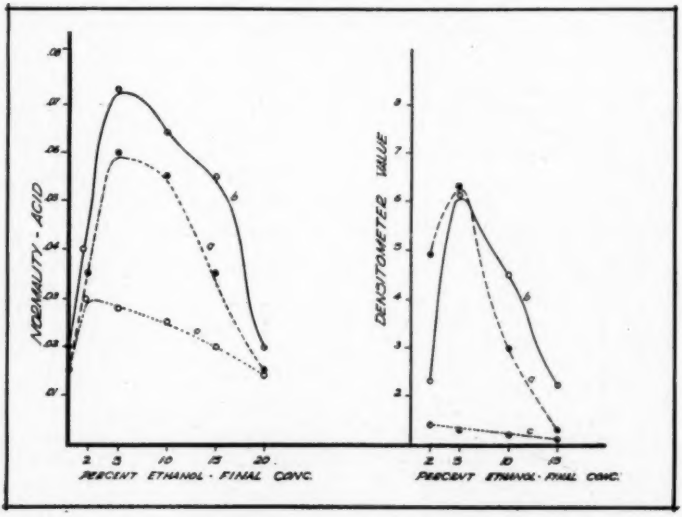

FIG. 1. Acid production (left) and yeast growth (right) with different concentrations of ethyl alcohol. Curve "a" for *Zygopichia Chevalieri* var. *Andersonii;* "b" for *Zygopichia Chevalieri* (M1); and "c" for *Zygohansenula californica*. Initial normality of media was 0.015.

pichia is quite high and the curves for their amount of growth are similar to the graphs of acid production. As is evident, the basal medium with 5 per cent ethanol furnishes an excellent growth medium for these two yeasts. With *Zygohansenula californica* on the other hand, the ethanol medium is a poor one for growth; here this yeast makes a miserable pellicle and grows as a faint sediment. It produces but a slight increase in acidity over that of the medium.

GLUCOSE SERIES.

Since the two varieties of *Zygopichia* employed in the ethanol series responded so similarly, only *Z. Chevalieri* var. *Andersonii* and *Zygohansenula californica* were used.

On this medium the species of *Zygopichia* made little sediment and, as figure 2 shows, its growth was light. Pellicle formation was good, however, up to 30 per cent glucose; 42 per cent showed scattered islands rather than a complete film. Figure 2 shows

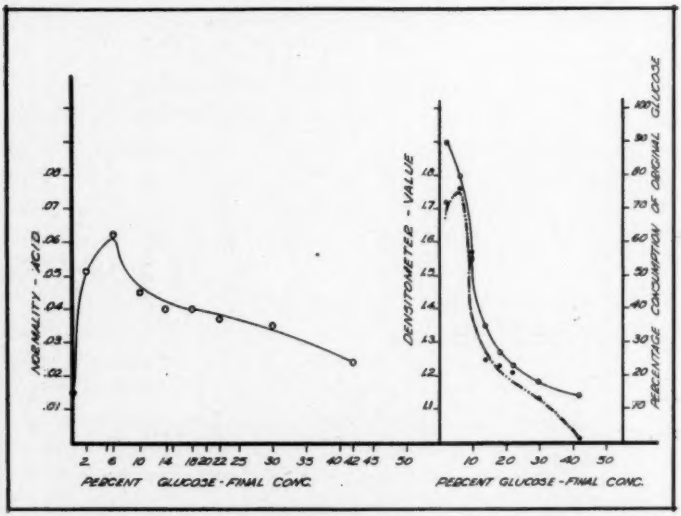

FIG. 2. Acid production (left) and yeast growth (right, dotted line) and glucose consumption (right, solid line) by *Zygopichia Chevalieri* var. *Andersonii* with different concentrations of glucose.

the decrease in growth as compared with the ethanol medium did not result in a corresponding decrease in acid production; rather, the peaks of the curves for the two series are nearly identical. It would seem that with this species pellicle cells are most active in acid production.

With *Zygohansenula* an entirely different response is made to the glucose medium than to the ethanol. Figure 3 shows acid production to be appreciable in all concentrations up to 45 per cent (the highest used), and growth to be excellent. Densitom-

eter values given are for one-half the culture concentration (5 cc. diluted with 5 cc. of sterile media) since the density of the cultures with the best growth were beyond the range of the instrument. *Zygohansenula* when inoculated into the sugar media rapidly made a pellicle and simultaneously developed a dense sediment. The pellicle did not creep up the wall of the flask in the fashion characteristic of *Zygopichia* in this medium.

NITRATE UTILIZATION AND REDUCTION

A comparison of nitrate utilization as evidenced by growth, and the presence of nitrite in the culture medium is given in table 1. The basal medium was used with a substitution of

TABLE 1

COMPARISON OF NITRATE UTILIZATION AND NITRATE REDUCTION BY SPECIES OF *Pichia* AND *Hansenula*

See text for description of methods.

Organism	Pellicle formation	Sedimentary growth	Gas production	Nitrite test
Zygohansenula californica	—	+	−	+
Hansenula saturna	islands	+	−	+
Hansenula anomala	+	+	+	+
Zygopichia Chevalieri (M1)	islands	−	−	−
Zygopichia Chevalieri (H175)	−	−	−	−
Zygopichia farinosa	islands	−	−	−
Pichia membranefaciens	−	−	−	−

6.0 g. KNO_3 for ammonium sulfate and peptone; 2 per cent glucose was the carbon source. The usual sulfanilic acid and alpha-naphthylamine test for nitrite was used; in cases where nitrite tests were negative a Zinc dust test was performed once in each series to preclude the obscure possibility that nitrate had been reduced beyond the nitrite stage. It will be seen that tests for the presence of nitrite agree with those for nitrate utilization and have simplicity in their favor.

When 2 per cent ethanol was substituted for glucose as the carbon and hydrogen source in the above medium no appreciable

difference in results was obtained; ethanol as a source of hydrogen did not result in the reduction of nitrate by any species of *Pichia* employed; the same held true when 2 per cent glycerin was used. Thus it would seem that it is not the absence of a dehydrogenase mechanism but of the nitratase system itself that is involved.

OBSERVATIONS ON FILM FORMATION

The process of film formation by microorganisms is a fascinating one—both to watch, and in view of the great complex of activity which must be involved.

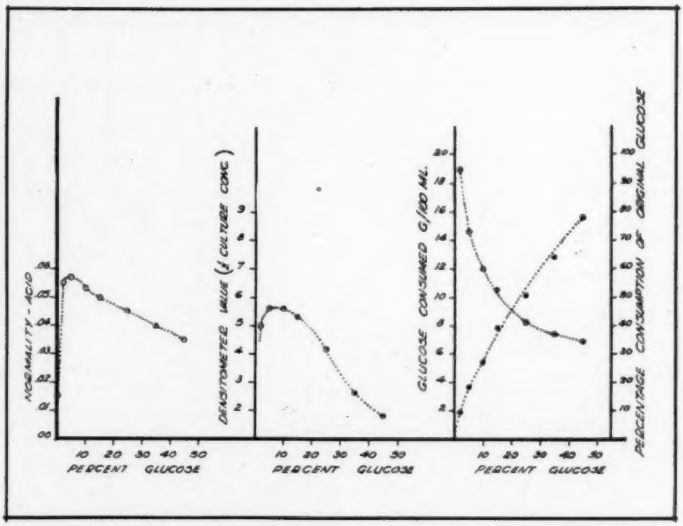

FIG. 3. Acid production (left), yeast growth (center), and glucose consumption (right) by *Zygohansenula californica* with different concentrations of glucose. Densitometer values given are for a 50 per cent dilution. Compare growth and acid production in figure 1 "c." Glucose consumed (solid circles), per cent consumption (open circles).

When *Z. Chevalieri* var. *Andersonii* (or any of the other species of *Zygopichia* mentioned) is inoculated into a flask containing a 2 per cent glucose-basal medium, the beginnings of a film can be observed after 12 hours at 25° C. An island (usually only one) of cells appears in the center and the surface is rapidly covered

with a thin film. Figure 4 gives the result of measurements on the surface area of a film formed under the conditions just described; at 48 hours the film was complete. The curve obtained resembles a portion of the familiar sigmoid growth curve. While media with a surface area as great as 18,000 square mm. have been inoculated with species of *Zygopichia*, the complete sigmoid curve has not been obtained, *i.e.*, the logarithmic phase persisted

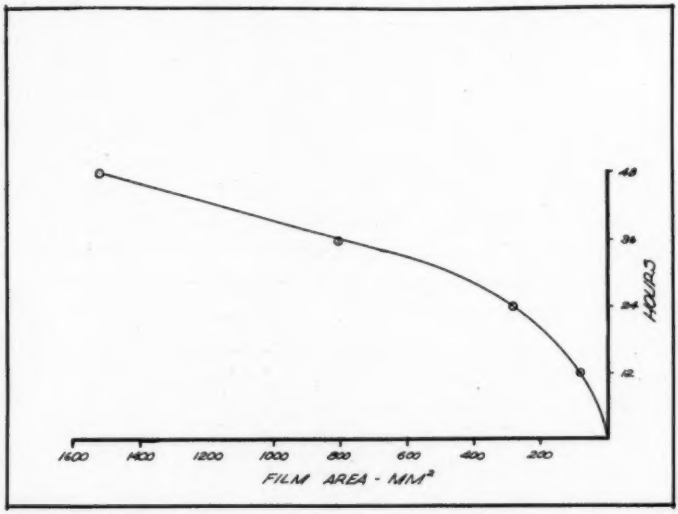

FIG. 4. Rate of growth of pellicle formed by *Zygopichia Chevalieri* var. *Andersonii* on a 2 per cent glucose medium. Surface of the liquid completely covered by 48 hours.

until the surface was covered. At the other extreme, films were formed quite readily in test tube culture with suitable media.

With *Zygopichia* there is little tendency to form a sedimentary deposit in a flask, and what little does form seems to fall from the surface growth. With *Zygohansenula* on the other hand, a good pellicle is formed in a glucose medium but this appears to be incidental to the growth of the yeast as a heavy sediment. This contrast in behavior of these two yeasts during growth is reflected in the photoelectric densitometer measurements which are about 3.5 times as high (logarithmic scale) for *Z. californica* as for *Z. Chevalieri* var. *Andersonii*.

Another difference between the mode of film formation by *Zygohansenula* and *Zygopichia* is seen in the nitrate test medium previously mentioned. Here *Zygohansenula* grows well, reduces nitrate and assimilates it, but the yeast makes little if any pellicle, growing almost exclusively as a sediment. This behavior is in contrast to that in media without nitrate, where growth is equally good, wherein it produces a well defined pellicle. A guess at an explanation for this behavior is that when nitrate is supplied a good hydrogen acceptor is also supplied; cells that might have been on the surface in the absence of nitrate (using atmospheric oxygen as the hydrogen acceptor) are in some, non-teleological (!), fashion restrained, inhibited, or relieved of the necessity of forming a film, *i.e.*, being at the surface. It should be borne in mind that in the nitrate medium *Zygohansenula* makes a good growth. *Zygopichia* in the same medium makes a miserable growth, as pellicle exclusively, at the expense of the available nitrogen in the yeast extract supplied; nitrite tests are invariably negative. Proof that the small growth made was at the expense of the yeast extract, and in no way connected with nitrate utilization, was obtained by preparing a purely synthetic medium replacing the yeast extract with known chemicals having growth nutrilite functions: biotin, inositol, thiamin, pantothenic acid, and pyridoxin. No growth was made in this synthetic medium.

DISCUSSION

This paper has attempted to point out some of the characteristics of acid production, film formation, and nitrate utilization of a few species of film-forming yeasts. Whether any of these characteristics possesses real taxonomic value necessitates the study of more isolates in all the genera concerned. From the evidence presented, however, it appears that though nitrate utilization may be the only criterion on which there is no overlap between the genera *Pichia* and *Hansenula*, it is indicative of a fundamental dissimilarity in the enzymatic make-up of the two groups—the former more oxidative in nature, the latter more reductive. While there are such species as *Pichia fermentans* and *Zygopichia farinosa* which are able to cause fermentations, thus

creating a resemblance to *Hansenula*, these should serve to emphasize that genera of yeasts are not clearcut affairs without transitional forms.

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VARIATIONS IN SINGLE ASCOSPORE ISOLATES OF SCLEROTINIA SCLEROTIORUM [1,2]

DONALD M. COE

(WITH 3 FIGURES)

The study of heterothallism in the genus *Sclerotinia* has received recent and intensive investigation by Drayton (**1**) and Gregory (**4**) and in some instances they have demonstrated certain species to be homothallic whereas other species are heterothallic. Keay (**7**) has shown *Sclerotinia sclerotiorum* (Lib.) Massee, *S. Trifoliorum* Erik. and *S. minor* Jagger capable of the production of normal apothecia from single ascospore isolates which confirmed Henson's report (**6**) of apothecial production from similar isolates of *S. sclerotiorum* and *S. Trifoliorum*. Godfrey (**3**) has also demonstrated homothallism in *S. Ricini* Godfrey, and more recently a self-fertile, homothallic condition has been reported for *S. sativa* Drayton and Groves (**2**). This paper is to report the results of certain preliminary studies with single ascospore isolates of *S. sclerotiorum* in which self-fertility and homothallism for sex is again demonstrated and also wherein a segregation for cultural and other characters was encountered. Variation in cultural characters of single ascospore isolates of an unnamed *Sclerotinia* which is the perfect stage of *Botrytis cinerea* has already been reported by Groves & Drayton (**5**).

ISOLATION OF SINGLE ASCOSPORES

During the spring of 1940, 31 randomly selected ascospores from an isolate of *Sclerotinia sclerotiorum* from cucumber and designated as isolate 8265 were cultured on potato-dextrose agar preparatory to starting giant oat cultures for obtaining sclerotia

[1] This work is a portion of a thesis submitted to the State College of Washington in partial fulfillment of the requirements for the degree of Doctor of Philosophy, January 29, 1943.

[2] The writer wishes to express his sincere appreciation to Dr. F. D. Heald, under whose direction this work was conducted, for his generous help and advice during the course of the work and the preparation of the manuscript.

for apothecial production. It was noted that a great dissimilarity existed in the general appearance of these isolates and that they could be readily divided into two groups of constant characters. Of the 31 isolates, 14 had every appearance of the parent isolate and were thereafter designated as the N or normal type and the remaining 17 were designated as the A or aberrant type. These differences will be described later.

The method used in isolating the single ascospores was to allow a mature apothecium to forcibly discharge ascospores onto plates of 3 per cent water agar. After incubating these plates for 8 to 12 hours at room temperature in order to allow short germ tubes to develop, the single ascospores along with a very small portion of the agar substratum were removed from thinly seeded portions of the plate. This was readily accomplished by cutting the agar with a fine, curved platinum needle and "scooping" out a small block of the agar substratum with a single, germinating ascospore on its surface. The use of a stereoscopic binocular microscope permitted direct observation of all manipulations, thus eliminating the possibility of obtaining even a small fragment of mycelium from a neighboring sporeling. The isolates thus obtained were designated as 0–1 to 0–31 inclusive as they were isolated and numbered consecutively without regard to the type of growth which followed.

DESCRIPTIVE DIFFERENCES

CULTURAL

Isolates of the N or normal type, when growing on potato-dextrose agar, resembled in every respect the parent type isolate from which they originated. Growth rates were approximately the same and the mycelium quickly covered the entire surface of the agar. The mycelial growth was floccose to patchy with the density of the mat increasing as it reached the periphery of the Petri dish. Numerous sclerotia were formed and they were of normal size, shape and color.

Isolates of the A or aberrant type, when grown at the same time as the N type, exhibited a much slower radial growth, and, after 5 days on potato-dextrose agar at 19–20° C., averaged 60 millimeters in diameter whereas the N isolates had grown in all cases

to the edge of the Petri dish (90 mm.). After 10 days on potato-dextrose agar plates, both types had entirely covered the surface of the agar, and sclerotia had just begun to form in the A type isolates, whereas they were nearing maturity in the N type isolates.

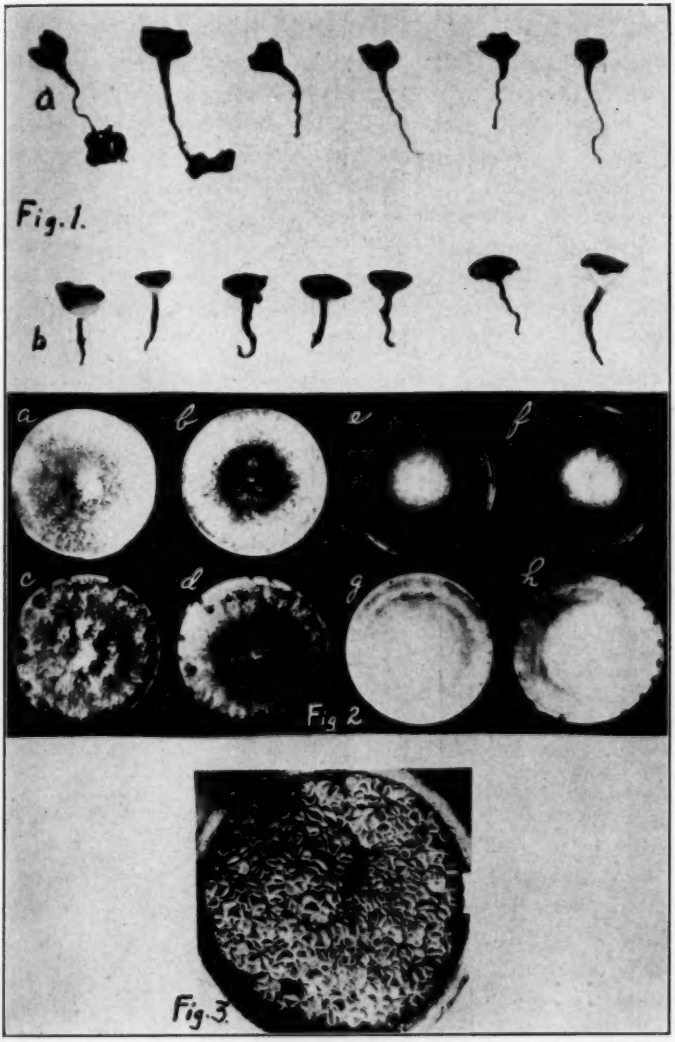
The character of the mycelial growth of the A type isolates was distinctly more cottony than the N type and formed a thick uniform mat over the entire surface of the medium. This mat was so dense, especially at the surface of the agar, that the passage of light was excluded and in test tube culture assumed a distinct brown color at the agar surface. The sclerotia produced by the A type isolates were few in number, more irregular in shape and showed a strong tendency to be flattened and depressed on the upper surface in contrast to the domed shape of the N type sclerotia. Cultural characters of the A and N types are summarized in figure 2.

In the giant oat cultures used for growing sclerotia for the production of apothecia, these same differences were evident. The bulk or mass of sclerotia obtained from the N type isolates was approximately four times greater than from the A type isolates of the same bulk and age.

APOTHECIAL PRODUCTION

Sclerotia grown from both N and A type isolates during the fall of 1940 were planted in the greenhouse on December 6, 1940, in separate sand cultures which included two of the A type and three of the N type. The first apothecia from these pot cultures appeared on February 4, 1941, and the last culture to start apothecial production was on February 20, 1941. This slight difference shows that the two types are not different in the length of

FIG. 1, *a*, apothecia of *S. sclerotiorum* of the A or aberrant type produced from single spore isolate; *b*, N or normal type apothecia from single spore isolate from the same parent isolate as *a*. FIG. 2, *a*, *b*, single ascospore isolates 0–11 and 0–10 of *S. sclerotiorum* respectively of the N type after growth for 5 days on potato-dextrose agar at 19–20° C.; *c*, *d*, the same cultures respectively after 10 days growth; *e*, *f*, A or aberrant type isolates 0–1 and 0–9 derived from single ascospores of *S. sclerotiorum* after 5 days of growth; *g*, *h*, the same cultures after 10 days growth. FIG. 3, a pot of N type apothecia produced by single ascospore isolate 0–10 of *S. sclerotiorum*.



FIGS. 1–3.

time necessary for the production of apothecia under these conditions. Similar results from plantings during the next winter substantiated this observation.

One of the more striking differences between these two types of *Sclerotinia sclerotiorum* is the greater number of apothecia produced from a given mass or bulk of sclerotia from an N type isolate than from the same bulk of sclerotia from an A type isolate. On November 29, 1941, 9 pot cultures of sclerotia which originated from single ascospore isolates were started in the greenhouse. Four of these isolates were of the N type, and five were of the A type. From the results shown in table 1, the great difference in

TABLE 1

NUMBER OF APOTHECIA PRODUCED BY N TYPE AND A TYPE SINGLE ASCOSPORE ISOLATES OF *Sclerotinia sclerotiorum* NO. 8265 IN SAND CULTURES IN GREENHOUSE AT PULLMAN, WASHINGTON, WINTER AND SPRING OF 1941–42

Isolate	Type	Quantity of sclerotia planted	Date apothecial production began	Number of apothecia		
				Expanded	Aborted	Total
0–26	A	5 gms.	Feb. 4	6	5	11
0–20	A	20 "	" "	15	20	35
0–9	A	17 "	" "	167	47	214
0–24	A	20 "	Mar. 28	60	27	87
0–1	A	20 "	Feb. 4	77	152	229
0–10	N	20 "	Feb. 13	728	126	854
0–11	N	20 "	Mar. 28	909	166	1075
0–15	N	20 "	Mar. 13	1350	71	1421
0–5	N	20 "	" "	928	151	1079

apothecial-producing ability is evident. All cultures produced a number of aborted or non-expanded apothecia which were recorded separately at two week intervals at which time all mature apothecia were removed without disturbing the sclerotia in the sand.

No further data were taken after June 6, 1942, although all of the pots were still producing a few apothecia. The pots were then allowed to become dry and remained so until October 1, 1942, during which time the temperatures became high and exceeded 100° F. on many days. Within two weeks after water was again added to the pots or by October 15, some of the

sclerotia resumed apothecial production, but in all instances only the N type isolates did so.

Figure 3 shows a pot of apothecia produced from sclerotia of single ascospore isolate 0–10. They are indistinguishable from the apothecia produced by the parent isolate 8265.

APOTHECIAL CHARACTERS

In addition to the cultural growth and the marked difference in apothecia-producing ability of these two types, the apothecia exhibited still another striking differential criterion. In fact, macroscopically, the apothecia produced by these two single ascospore types are more different than are the apothecia of *Sclerotinia sclerotiorum* and *S. Trifoliorum*.

TABLE 2

COMPARISON OF FIFTY ASCUS AND ASCOSPORE MEASUREMENTS FROM SINGLE SPORE ISOLATES 0–5 AND 0–1 OF *Sclerotinia sclerotiorum* NO. 8265

Isolate		Dimensions in microns	
		Ascospores	Asci
0–5 (N type)	(1)	12.61 × 6.63	135.99 × 8.06
	(2)	11.56–14.40 × 5.66–9.02	117.39–150.42 × 6.90–8.97
0–1 (A type)	(1)	12.30 × 6.89	134.76 × 7.91
	(2)	11.33–14.16 × 6.37–7.32	117.30–154.56 × 6.90–8.97

(1) Average, (2) Range.

The apothecia of the A type are darker colored than the N type and the blackening of the stipe extends in some instances well onto the lower surface of the disc. The hymenium is dark brown rather than a light tan as in the N type. The margin of the discs is generally ruffled rather than symmetrical and these are seldom fully expanded as are those of the N type (FIG. 1). In texture, the apothecia of the A type are rather soft and watery as compared to the firm, wax-like texture of the apothecia of type N. Microscopically, the apothecia are also unlike. Crushed hymenial tissue of the A type apothecia exhibits a high ratio of paraphyses to asci in comparison with the N type. The asci and ascospores are more irregular in outline although they compare very closely in size. In table 2 the ascus and ascospore

measurements are presented as recorded from isolates 0–5 (N type) and 0–1 (A type).

SINGLE SPORE REISOLATIONS

On May 20, 1942, isolations of single ascospores were made from apothecia produced by the single-spore isolates by the same method used in obtaining the original cultures from single ascospores. The resulting isolates were grown on potato-dextrose agar in parallel with the parent isolates at 19–20° C. and corresponded exactly in all cultural characters to the parent single ascospore isolates from which they originated. Sixty-three second generation single ascospore isolates of the A type were thus obtained and 31 of the N type were grown.

DISCUSSION

The significance of the results of these isolations of single ascospores cannot be interpreted fully until more extensive work can be conducted. In addition to confirming previous reports (**6**, **7**) of homothallism in *Sclerotinia sclerotiorum*, the discovery of distinct morphological types suggests that, although this fungus is homothallic for sex, it may be subject to segregation for other characters. That no obvious differences between the parent isolate and the N type isolates were observed introduces a possibility of multiple factors being involved. Continued investigation along physiological and pathological lines may eventually reveal criteria in which the N type differs from the parent type as well as further differences between the A and N types. Lack of time precluded inoculations with the various single ascospore lines.

It is interesting to note that the A type has never been isolated directly from diseased plant material by the author nor by any other investigators on the basis of published reports. This may indicate that the A type is incapable of parasitism, that a sexual union by anastomosis occurs, or that the microconidia of *Sclerotinia sclerotiorum* do have a sexual function. Further substantiation of the view that the A type is possibly nonpathogenic lies in the fact that no published records report a differentiation of single ascospore isolates of *S. sclerotiorum* into two distinct types on a basis which approximates a 50 : 50 ratio and, therefore, that all

cases of infection are caused by either N or parent types. Cultures derived from single ascospores of isolate 8257 of *S. sclerotiorum* (isolated from lettuce) and isolate 32 of *S. Trifoliorum* (isolated from *Lentilla lens*) revealed no differences such as in the case here reported. It is entirely possible that previously reported isolations of single ascospores were from cultures which had been derived from mono-ascosporic infections. However, any definite conclusions regarding the origin of these types or their possible significance must be postponed until further experimental work is performed.

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NEW NORTH AMERICAN AGARICS

ALEXANDER H. SMITH

The species described herein were collected in various parts of the United States, but the majority were found while the writer was collecting in the Olympic National Park during the fall of 1941. This expedition was part of a larger project involving the agarics of the western United States and was made possible by a grant from the Horace H. Rackham School of Graduate Studies of the University of Michigan. As a part of this expedition, the writer spent several weeks during the summer of 1941 in the vicinity of Payette Lakes, Idaho, and during the season of 1943 Mr. Wm. B. Gruber spent the summer and fall collecting and photographing agarics in the same region. As a result of our combined efforts a number of very unusual species were discovered in this region and are included here. Both my own and Mr. Gruber's collections have been deposited in the Herbarium of the University of Michigan. The color terms within quotation marks are taken from "Color Standards and Color Nomenclature" by R. Ridgway, Washington, D. C., 1912. The color terms not in quotation marks are based on Ridgway's system of nomenclature but do not represent actual comparisons. This is true in particular for such common terms as fuscous, tawny, ochraceous, ferruginous, vinaceous, drab etc.

Agaricus vinaceo-umbrinus sp. nov.

Pileus 1–2.5 (3.5) cm. latus, obtusus demum campanulatus vel plano-umbonatus, siccus, fibrillosus vel subfurfuraceus, siccatus vinaceo-umbrinus vel fuligineus; lamellae liberae, confertae, angustae, umbrinae; stipes 2.5–4 cm. longus, 3–5 mm. crassus, aequalis, siccatus cum pileo concolor; annulus fibrillosus; sporae 6–7 × 5–5.5 μ; cheilocystidia subcapitata, 38–52 × 4–5 μ. Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Cisco, Texas, Sept. 15, 1935, E. A. Smith.

Pileus 1–2.5 (3.5) cm. broad, obtuse with an incurved margin when young, expanding to campanulate or plano-umbonate, surface appressed fibrillose-silky or minutely furfuraceous around

the disc, color when fresh not known, when dried evenly "drab" to "light drab" (dark gray) or with a tinge of vinaceous ("sorghum-brown"); flesh thin, pale avellaneous when dried, odor and taste not known; lamellae free, remote in dried pilei, close, narrow, dark blackish brown when dried, edges fimbriate; stipe 2.5–4 cm. long, 3–5 mm. thick, equal, stuffed with a fibrillose pith, colors when fresh not known, when dry concolorous with the pileus above, "sorghum-brown" (dull vinaceous brown) around the base, densely appressed fibrillose up to the fibrillose evanescent superior annulus, fibrillose sheath soon breaking into zones or patches and the fibrils dark drab in color, apex silky and blackish when dried, cortex also very dark colored.

Spores broadly ovoid, bister in KOH, 6–7 × 5–5.5 μ, smooth, no apical pore visible; basidia 19–23 × 7–8 μ, four-spored, pale olivaceous gray in KOH; pleurocystidia not differentiated; cheilocystidia forming a sterile band on the gill edge, filamentose with a small knob at the apex, 38–52 × 4–5 μ, pale olivaceous in KOH; gill trama parallel, the hyphae 8–15 μ in dia., pale olivaceous brown in KOH; pileus trama homogeneous beneath a cuticle of radially arranged hyphae 5–9 μ in dia., no clamp connections seen, tramal body of interwoven pale olivaceous hyphae when revived in KOH, hyphae 5–12 μ in dia.

The species was found scattered to subcespitose on soil under live oak, and is known only from the type locality.

Observations: Although unquestionably a species of *Agaricus*, this fungus has many characters not possessed by any other known American species. The olivaceous color assumed by all parts of the carpophore when sections are mounted in KOH is distinctive and unique in this genus. I know of no other *Agaricus* with similar cheilocystidia. The olive color diffuses through the mounting medium causing the latter to become sordid olivaceous also, and the reaction can thus be observed without the aid of a microscope. The vinaceous color present in the carpophore and the surrounding mycelium, and the very dark color of the dried carpophores are also distinctive but not so unusual for the genus. When dried the carpophores are about as dark as those of *A. echinatus* Fries but, of course, the two can be readily separated by the character of the cuticle of the cap. Unfortunately the colors of the fresh specimens are not known. They were described simply as "dark colored mushrooms." In a situation such as this however, it is important to know the changes that take place

as the development of the carpophores proceed. The relationships of this fungus are difficult to determine, and probably cannot be stated accurately until such time as the agaric flora of our southwest has been more critically investigated.

Agaricus eastlandensis sp. nov.

Pileus 6–10 mm. latus, convexus demum planus, ad marginem appendiculatus, siccus, fibrillosus, albidus demum pallide luteus; lamellae liberae, confertae, angustae, incarnatae dein umbrinae; stipes 10–15 mm. longus, 1.5–2.5 mm. crassus, aequalis vel bulbosus, albidus demum avellaneus, sursum sericeus, deorsum fibrillosus; annulus fibrillosus, albidus; sporae subglobosae vel late ellipsoideae, (8) 9–11 × 7–9 μ. Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Eastland, Texas, Aug. 28, 1938, E. A. Smith.

Pileus 6–10 mm. broad, convex becoming plane, margin at first fringed with fibrils left by the broken veil, surface dry, appressed silky-fibrillose, white or whitish, in age creamy yellowish on the disc, when dried pale buff over all or the disc slightly darker, not changing to yellow when cut or bruised; flesh very thin, white, odor and taste not recorded; lamellae free but approximate to the stipe, close, narrow, dull vinaceous but finally blackish brown, edges even; stipe 10–15 mm. long, 1.5–2.5 mm. thick, equal above a bulbous base, white or whitish but gradually becoming brownish beneath a thin coating of appressed white fibrils, silky above the annulus and tinged pinkish, bulb consisting of a mass of soil held together by a copious mycelium; annulus single, fibrillose, apical to superior, white, soon evanescent.

Spores subglobose to broadly ellipsoid (8)9–11 × 7–9 μ, pale bister in KOH, smooth, with a flattened apex and hence appearing slightly truncate; basidia two- and four-spored, 22–26 × 8–10 μ, hyaline in KOH; pleurocystidia not differentiated; cheilocystidia basidia-like, pale fuscous in KOH but becoming hyaline, many sporulating basidia seen on the gill edge; gill trama parallel to subparallel, the subhymenium thin and of filamentose hyphae; pileus trama with the cuticle of radially arranged hyphae 5–10 μ in dia., hyaline in KOH, no clamp connections seen, tramal body hyaline in KOH, of interwoven hyphae 8–12 μ in dia., hyaline metallic-appearing lactifers numerous.

On exposed soil in an open oak grove after heavy rain, Eastland Texas, Aug. 28, 1938, E. A. Smith.

Observations: The annulus is the same type as that of *Agaricus campestris* but even more fibrillose and evanescent. The species is related to *A. campestris*, but is obviously very distinct both by

virtue of the spore size and very small delicate stature of the carpophores. It can be characterized as one of the smallest species in the genus but having exceptionally large spores. The carpophores are very soft and in wet weather discolor to dark sordid brown soon after maturity much in the same manner that the white form of *A. campestris* discolors. The change is caused by a change in color of the cell sap, and is not caused by the dark spores obscuring the true color.

Clitocybe Gruberi sp. nov.

Pileus 8 cm. latus, convexus, siccus, pallide flavidus; lamellae confertae, angustae, decurrentes et reticulatae, pallide flavidae; stipes 3 cm. longus, 2.5 cm. crassus, solidus, intus pallidus, glaber, pallide flavidus, impolitus; sporae 11–14 × 4.5–5.5 μ, laevae; cheilocystidia 38–64 × 8–10 μ, subventricosa sed elongata. Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Juliet, Idaho, May, 1943, Gruber *26*.

Pileus 8 cm. broad, broadly convex with an inrolled margin, surface dry and unpolished, evenly pale yellow, "Naples yellow" to "straw yellow" or "primuline yellow" in places where in contact with sticks etc., the margin downy-tomentose and even; flesh thick and firm, white, pallid yellowish when dried, unchanging when cut or bruised, odor radish-like or somewhat sweetish, taste agreeable and mild; lamellae close, about 3 tiers of lamellulae, narrow (material all young), long-decurrent, anastomosing or forming a more or less distinct reticulum on the stipe, concolorous with pileus or paler and duller, edges even; stipe very short, thick and firm, 3 cm. long, 2.5 cm. thick, solid, whitish within, surface concolorous with pileus, glabrous, apex appearing more or less unpolished, base without conspicuously adhering mycelium or rhizomorphs.

Spores white in mass, hyaline or a few with a yellowish tinge when revived in KOH, 11–14 × 4.5–5 μ, subcylindric, obtuse at ends, smooth, not amyloid; basidia 42–48 × 9–11 μ, clavate with narrow flexuous pedicels, four-spored, pallid and content granulose in KOH; pleurocystidia rare and found mostly very near the gill edge, similar to cheilocystidia; cheilocystidia 38–46 × 8–10 μ, slightly ventricose above the middle and then tapered to a long often flexuous forked or variously branched neck, sometimes with a small apical head but apex usually acute, hyaline and thin-walled; gill trama compact, homogeneous, of narrow subparallel hyphae interwoven with contorted lactifers, hyaline in KOH; pileus trama homogeneous, cuticle of interwoven non-gelatinous narrow (4–7 μ) hyphae with golden yellow contents, many hyphal

tips present as pilocystidia, the end cell not differentiated except for a narrow, short proliferation, the cells 20–35 × 4–7 μ, proliferation 10–15 μ long and 2–4 μ at base, the apex often 4–6 μ in dia., clamp connections not present.

Singly under conifers, near Juliet, Idaho.

Observations: This is obviously a very robust *Clitocybe* even though the type specimen is not particularly large. It was young and immature when collected, but in spite of this a good spore deposit was obtained. Superficially it resembles a young robust carpophore of *Cantharellus cibarius* in color and in the unpolished appearance of the pileus, but is readily distinguished by its gill characters and spores. In certain respects it resembles carpophores of some of the robust species of *Leucopaxillus*, but its spore characters preclude inclusion in that genus. *Leucopaxillus pulcherrimus* (Peck) S. & S. has similar colors, to judge from descriptions, and the same unpolished surface of the pileus. The long cylindric spores, the color of the carpophore, and the cheilocystidia are an unusual combination of characters in *Clitocybe*.

Hygrophorus inocybiformis sp. nov.

Pileus 3–6 cm. latus, conicus vel obtusus, demum campanulatus vel umbonatus, siccus, fibrillosus vel squamulosus, subumbrinus; lamellae arcuatae vel brevissime decurrentes, latae, subdistantes, pallide cinereae; stipes 3–6 cm. longus, 5–12 mm. crassus, subaequalis, solidus, siccus fusco-fibrillosus, sursum albidus; sporae 10–13 × 5–6.5 μ. Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Lick Creek Summit, Idaho National Forest, September, 1943, Wm. B. Gruber.

Pileus 3–6 cm. broad, conic to obtuse when young, the margin incurved and fringed with the remnants of a fibrillose veil, expanding to campanulate or obtusely umbonate, sometimes plane or the disc slightly depressed, surface dry and innately fibrillose to fibrillose-squamulose, dark gray ("drab") over all or with drab fibrils over a pallid background in age; flesh whitish or tinged pallid gray near surface, thin except in the disc, soft and fragile, unchanging when cut or bruised, odor none, taste mild; lamellae short-decurrent or arcuate, broad, subdistant, rather thick and firm, waxy, a few forked, pallid to grayish buff ("pale olive-buff"), edges even; stipe 3–6 cm. long, 5–12 mm. thick, subequal, the base at times slightly narrowed, solid, fleshy, white within, surface streaked with dark grayish brown fibrils up to the zone left by the broken veil, dry over all, white and glabrous to appressed silky toward the apex.

Spores white in mass, 10–13 × 5–6.5 μ, ellipsoid, smooth, not amyloid; basidia four-spored, 62–84 × 10–12 μ; pleurocystidia and cheilocystidia not differentiated; gill trama of divergent hyaline hyphae 6–8 μ in dia.; pileus trama with a cuticle of radially arranged nongelatinous hyphae 10–15 μ in dia., their contents smoky in color and the end-cells more or less pointed, clamp connections abundant; the hyphae of the flesh proper hyaline, 8–14 μ in dia.

Gregarious to scattered under spruce and balsam fir. It was collected in 1941, A. H. Smith no. 15919 and by Gruber in 1943 in the same region.

Observations: Because of its fibrillose to squamulose pileus this fungus has somewhat the stature and appearance of an *Inocybe* or of a small species of the *Tricholoma terreum* group. Actually, the fungus is closely related to *H. pustulatus*, but is readily distinguished by its spores and by the fibrillose veil. *H. pustulatus* was found in the same area in 1943 and appeared to have a perfectly dry stipe. Previously (Smith, **1937**) reported a collection from California with a thin gelatinous universal veil. The latter was found during very wet weather, whereas the Idaho collection was made during dry weather. Since large numbers of carpophores were not available for study in either instance, the discrepancy is merely pointed out here in the hope that any who find *H. pustulatus* will pay particular attention to the presence or absence of a gelatinous veil. *H. olivaceo-alubus* has both a glutinous sheath and one of fuscous fibrils beneath it. Consequently, *H. inocybeformis* might be considered closely related to it.

Hypholoma dispersum var. **idahoense** var. nov.

Pileus 1–2.5 cm. latus, conicus vel campanulatus demum convexus vel umbonatus, glaber, ad marginem appendiculatus, obscure fulvus demum sordide ochraceus; sapor acerbus; lamellae confertae, adantae, angustae, albidae demum obscurae; stipes 6–8 cm. longus, 1–2 mm. crassus, aequalis, deorsum obscurus, sursum albidus demum sordidus, fibrillosus; sporae 7–8.4 × 3.5–4 μ. Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Lake Fork Ranger Station, Idaho National Forest, Idaho, Oct., 1943, Wm. B. Gruber *P-81*.

Pileus 1–2.5 cm. broad, obtusely conic with an incurved margin, becoming campanulate to broadly convex with a small conic umbo, surface moist and glabrous except for the appendiculate margin, veil remnants adhering to margin as a thin submem-

branous band or band broken up into patches, subhygrophanous, dull tawny to cinnamon-brown on the disc, paler toward the margin, fading around the disc first to sordid ochraceous; flesh thin, pallid, odor not distinctive, taste distinctly bitter and leaving a persistent after taste (in fresh material); lamellae close, ascending adante, narrow to moderately broad, white or whitish, becoming sordid grayish brown, edges white floccose; stipe 6–8 cm. long, 1–2 mm. thick, equal, cartilaginous, sordid brown to bister below and gradually darkening upward, at first covered by a conspicuous coating of white fibrils causing it to appear white or silvery, apex whitish beneath the fibrils but eventually becoming brownish, base conspicuously strigose with white to tawny hairs or mycelium.

Spores 7–8.5 × 3.5–4 μ, ellipsoid, apex truncate, dull tawny brown in KOH; basidia 22–26 × 5–6 μ, four-spored; pleurocystidia abundant, mucronate, 26–34 × 8–10 μ, with a highly refractive irregular amorphous mass or body in central portion; cheilocystidia cylindric to subventricose, 30–36 × 4–6 μ, apices rounded, hyaline, content homogeneous; gill trama parallel, hyaline or nearly so; pileus trama with a thin subgelatinous pellicle of hyaline more or less radially arranged hyphae 3–5 μ in dia. and bearing clamp connections, beneath this a hypoderm of radially arranged hyphae 8–12 μ in dia. which are dark yellowish in KOH, the remainder of the trama paler and not compactly interwoven.

Cespitose to subcespitose on conifer logs, Lake Fork Ranger Station, Idaho National Forest, Idaho, Oct., 1943, Wm. B. Gruber *P-81*.

Observations: This variety differs from var. *typicum* in its slender cheilocystidia, cespitose habit, paler colors of the young gills and apex of the stipe, and by the very bitter taste. It was found during a dry season during which very few agarics fruited, but was found in quantity in the one locality.

Hypholoma olympianum sp. nov.

Pileus 2.5–4 (6) cm. latus, obtusus demum planus vel umbonatus, canescens, glabrescens, pallide alutaceus; sapor amarus; lamellae confertae, adnatae sed secedenti-liberae, pallide luteae; stipes radicatus, 5–7 cm. longus, 3–6 cm. crassus, sursum luteus, deorsum sordide ferrugineus; sporae 6–7.5 × 4–4.5 μ, obscure ferrugineae. Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Storm King Mountain, Olympic National Park, Wash., Oct. 16, 1941, A. H. Smith *18,003*.

Pileus 2.5–4 (6) cm. broad, obtuse to convex and with an incurved margin at first, expanding to plane or retaining a slight obtuse umbo, surface at first canescent from a thin coating of whitish silky fibrils but soon glabrescent or fibrils more or less persistent toward the margin, moist, "cinnamon buff" to "clay-color" on disc and paler yellow toward the margin (sordid honey color to alutaceous); flesh hard and thick in the disc, abruptly thinner toward the margin (± 3 mm. at the stipe), pallid but soon lutescent where cut or broken, odor not distinctive, taste quickly and decidedly bitter; lamellae close, ± 33 reach the stipe, 3–4 tiers of lamellulae, narrow (3–4.5 mm.), bluntly adnate but seceding, "cream-buff" (very pale yellowish) young, "buckthorn brown" in age (dark sordid yellowish brown) and often with dark rusty spots, edges even and pale yellowish; stipe 5–7 cm. long, 3–6 mm. thick, subfusoid to equal above a long tapered pseudorhiza, tubular to hollow, surface densely white-fibrillose from veil remnants, apex yellowish and pruinose, becoming yellowish where handled and finally dark sordid brown, more or less glabrescent.

Spores dull cinnamon brown in mass, when revived in KOH very pale dull brown, ellipsoid to ovoid, smooth, apical pore not evident under ordinary magnifications, 6–7.5 × 4–4.5 μ; basidia four-spored, 18–22 × 5–6 μ, projecting somewhat when sporulating; pleurocystidia abundant, 22–36 × 9–14 μ, ventricose and mucronate, with an irregular highly refractive mass in the enlarged portion; cheilocystidia abundant, 18–28 × 4–8 μ, subclavate to subventricose, the apices rounded; gill trama subregular, homogeneous; pileus trama with a very thin pellicle of narrow (1.5–2.5 μ) hyaline, subgelatinous (when revived in KOH) hyphae, beneath this a region of brownish compactly arranged larger hyphae of about the same diameter as those making up the trama, clamp connections present.

Gregarious to scattered around Douglas fir stumps, Storm King Mountain, Olympic National Park, Washington.

Observations: *H. olympianum* is very similar to *H. radicosum* Lange but there is a distinct difference in the color of the spores when both are compared under the microscope. Those of *H. radicosum* are distinctly darker in color. There is a second distinct difference in the color of the fibrils over the basal portion of the stipe. In *H. radicosum* dark tawny fibrils cover the lower portion and often become arranged in patches. These are not present in *H. olympianum*. In the latter species, the change in color on the bruised portions of the stipe may be significant, but

this needs to be verified by many observations since other species in the genus show this character at times and it does not appear significant.

Hypholoma subochraceum sp. nov.

Pileus 2–4 cm. latus, convexus, glaber, glutinosus vel viscidus, subochraceus; lamellae confertae, angustae, pallide luteae demum sordide cinnamomeae; stipes 5–9 cm. longus, 5–7 mm. crassus, aequalis, sursum luteo-albus, deorsum fusco-ferrugineus; sporae 5–6 × 2.5–3 μ.—Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Mt. Angeles, Olympic Mountains, Wash., Oct. 4, 1941, A. H. Smith *17,526*.

Pileus 2–4 cm. broad, convex with an inrolled margin and becoming broadly convex to plane, surface glabrous except for scattered fibrillose flecs along the margin from the broken veil, glutinous (slimy as in *Lactarius mucidus*) when wet, under a lens appearing somewhat appressed fibrillose beneath the gluten, very pale ochraceous tawny on the disc, "massicot yellow" (pale clear yellow) near the margin, when young more or less "cinnamon-buff" (pallid alutaceous) over all; flesh thin, firm, equal, yellowish, unchanging, odor none, taste mild; lamellae close, ± 35 reach the stipe, 2 tiers of lamellulae, equal and narrow in young caps, adnate becoming depressed-adnate, pale yellow ("margeurite yellow") young, becoming tinged sordid cinnamon-brown at maturity, edges even; stipe 5–9 cm. long, 5–7 mm. thick at apex, equal or slightly enlarged downward, tubular to hollow, surface over lower portion pale yellowish white from a thin coating of white fibrils which extends up to the evanescent zone left by the broken veil, yellowish beneath the fibrils (concolorous with the gills), apex yellow and silky, soon becoming sordid rusty brown from the base upward and glabrescent.

Spores dull snuff brown in mass, very pale brown under the microscope, smooth, 5–6 × 2.5–3 μ, ellipsoid to narrowly ellipsoid, apical pore not visible under ordinary magnifications; basidia four-spored, 16–18 × 4–5 μ, projecting only slightly when sporulating; pleurocystidia very abundant, ventricose-mucronate, 32–46 × 10–14 μ, with a highly refractive irregular body or bodies in the enlarged portion when revived in KOH; cheilocystidia similar to pleurocystidia and abundant; gill trama subregular and brownish when revived in KOH; pileus trama homogeneous beneath a thick (75–150 μ) gelatinous pellicle of narrow (2–4 μ) yellow hyphae, clamp connections present.

Cespitose on conifer logs, Mt. Angeles, Olympic Mountains, Wash.

Observations: The distinctive features of this species are the very slimy pileus when wet, the small spores and yellow gills. The spores are very pale and not truly purple brown in mass, but they are thick-walled and have a small apical pore and hence are typical in structure if not in color. The cystidia of course are typical of *Hypholoma*. *H. tsugaecola* is close but has larger spores and lacks cystidia with the characteristic highly refractive content. Its spores are also different, being typical for the genus in color. *H. incomptum* Massee, is also described as being viscid but should differ markedly in spore size (8 × 3.5 μ) as well as in the yellow scales on the stipe and in the color of the pileus.

Melanoleuca eccentrica sp. nov.

Pileus 4–6.5 cm. latus, umbonatus vel subplanus, glaber, pallide alutaceus; odor et sapor subspermaticus; lamellae confertae, angustae, pallidae; stipes eccentros, 4–5 cm. longus, 9–10 mm. crassus, solidus, subavellaneus, glaber; sporae 7–8 × 4–5 μ. Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Olympic Hot Springs, Olympic National Park, Wash., Oct. 8, 1941, A. H. Smith *17,667*.

Pileus 4–6.5 cm. broad, obtusely umbonate with an inrolled margin, expanding to nearly plane, margin cottony when young, surface glabrous, moist and opaque, "warm buff" over all when young (pale buff to alutaceous), becoming paler and more yellowish ("cartridge buff") along the margin, finally nearly "cinnamon buff" on the disc; flesh thick, 1 cm. in the umbo, abruptly thinner (± 5 mm.) toward the stipe, pallid ("tilleul buff"), very firm, unchanging when bruised, odor when cut subspermatic as in many species of *Inocybe*, taste similar and very disagreeable; lamellae crowded, shallowly adnexed, narrow (3–4 mm.), equal, pallid, edges uneven; stipe eccentric, 4–5 cm. long, 9–10 mm. thick, equal or enlarged below, stuffed solid, interior pallid, surface darker and more or less avellaneous, appressed fibrillose-striate, glabrous.

Spores 7–8 × 4–5 μ, ellipsoid, covered with minute strongly amyloid warts; basidia four-spored, 34–40 × 7–8 μ; pleuro- and cheilocystidia not differentiated; gill trama not amyloid, regular to subregular, cells 5–10 μ in dia. and cylindric, the length very variable; pileus trama with a pellicle of interwoven narrow (3–6 μ) hyphae, the remainder floccose and loosely interwoven, clamp connections not present.

Gregarious under conifers, Olympic Hot Springs, Olympic National Park, Wash., Oct. 8, 1941 (*16,667*).

Observations: The pale yellowish brown color, the taste and the eccentric stipe along with the pallid gills are distinctive. The spores apparently are white in mass, but the only deposit obtained was thin. The lack of cheilocystidia is also characteristic but is a more difficult character to use since very careful observations must be made. *M. praecox* Murr., *M. mirabilis* (Bres.) Singer, *M. dehiscens* (Kalchbr.) Singer and *M. angelesiana* are other species in which the cheilocystidia are lacking.

Melanoleuca angelesiana sp. nov.

Pileus 5–7 cm. latus, umbonatus vel planus, glaber, subviscidus olivaceo-fuscus; lamellae confertae, latae, cinereae mox albidae, demum fusco-maculatae; stipes 5–6 cm. longus, 10–12 mm. crassus, olivaceo-fuscus, glaber; sporae 7–8 (9) × 4.5–5 (6) μ; cheilocystidia nulla.—Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Lake Angeles, Olympic Mts., Wash., June 25, 1939, A. H. Smith *14,633*.

Pileus 5–7 cm. broad, at first with a low obtuse umbo and an inrolled margin, becoming plane or the margin uplifted, glabrous, subviscid to the touch but lacking a gelatinous separable pellicle, opaque when moist, color fuscous to "buffy brown" (dull olive-brown), margin paler grayish brown ("hair-brown"); flesh 2–3 mm. thick at the stipe, tapered to the margin, watery gray when moist, pallid when faded, odor none, taste mild; lamellae crowded, ± 75 reach the stipe, ± 3 tiers of lamellulae, moderately broad (5–7 mm.), narrowed toward the margin, horizontally adnate to slightly adnexed, pale ashy gray becoming pallid or white, the edges even and staining sordid brownish where bruised; stipe 5–6 cm. long, 10–12 mm. thick near the apex, flared slightly at the base and apex, surface concolorous with the pileus or paler, longitudinally fibrous striate, glabrous or with scattered fibrils caused by the shredding of the cuticle, hollow and sordid watery gray within.

Spores 7–8 (9) × 4.5–5 (6) μ, ellipsoid, covered with strongly amyloid minute warts, with a subhilar depression; basidia four-spored; pleuro- and cheilocystidia not found; gill trama interwoven, not amyloid; pileus trama homogeneous beneath a surface layer of more or less interwoven to subradial hyphae with dark brown contents and not narrower than the hyphae of the trama proper.

Singly along the trail at Lake Angeles, Olympics, Wash., June 25, 1939, A. H. Smith *14,633*.

Observations: This species is characterized by the grayish gills which become white in age and stain brownish if bruised, by the lack of cheilocystidia, and lack of any distinctive odor or taste. Unfortunately a spore print was not obtained. *Melanoleuca praecox* Murr. also lacks cheilocystidia, but no mention is made of its gills staining sordid brownish and their color is given as "avellaneous with a murinous tint." This should indicate that its gills and pileus are practically the same color. Such is not the case in *M. angelesiana*.

Pholiota carbonaria sp. nov.

Pileus (1) 2–4 (5) cm. latus, convexus vel planus, viscidus, ferrugineo-squamulosus dein subglaber, luteus dein subfulvus; lamellae confertae, adnatae, angustae, pallidae dein subfulvae; stipes 3–6 cm. longus, 3–6 mm. crassus, squamosus, sordide luteus, squamis cinnabarinis; sporae 5–6.5 × 4–5.5 μ; pleurocystidia 46–63 × 9–16 μ, fusoide ventricosa.—Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Crescent City, Calif., Dec. 7, 1937, A. H. Smith *9500*.

Pileus (1)2–4 (5) cm. broad, broadly convex, becoming plane or slightly umbonate, sometimes the disc slightly depressed in age, surface with a separable viscid pellicle and at first covered by concentric rows of small "hazel" to "ferruginous" fibrillose scales (scales very bright fiery red) on a "warm buff" to "antimony-yellow" (pale yellow) background, ground color gradually changing to nearly "cinnamon-brown" (rather dark brown) in age and the scales becoming a duller reddish brown; flesh watery brown, thick in the disc, tapering slightly toward the margin, odor and taste not distinctive; lamellae crowded, bluntly adnate, narrow, equal, white when young, sometimes grayish (not yellow), becoming nearly "snuff-brown" (dull yellowish brown) at maturity, edges slightly crenulate; stipe 3–6 cm. long, 3–6 mm. thick, equal, compressed or terete, flesh sordid watery yellow, solid below but tubular above, surface covered to near the apex by small "hazel" or "ferruginous" recurved fibrillose scales, ground color sordid yellowish, the apex yellowish and merely pruinose.

Spores 5–6.5 × 4–4.5 μ, ellipsoid to subovoid, not truncate, smooth, nearly cinnamon-brown when revived in KOH; basidia four-spored; pleurocystidia very abundant, 46–63 × 9–16 μ, fusoid ventricose, subacute, smooth or with a resinous encrustation over the apex; cheilocystidia 24–32 × 8–12 μ, subsaccate to subfusoid, obtuse, hyaline; gill trama with a central strand of regularly arranged floccose hyphae, the subhymenium gelatinous

(when revived in KOH); pileus trama homogeneous beneath a thick gelatinous pellicle.

Cespitose to densely gregarious on burned soil and charred wood, Lake Tahkenitch, Ore., Nov. 10, 1935 (*3406*); Nov. 11 (*3418*); Booth, Ore., Nov. 24 (*3616*); Trinidad, Calif., Nov. 27, 1935 (*3638*); Orick, Calif., Dec. 4 (*3773*); Crescent City, Nov. 22, 1937 (*9003*); Dec. 3 (*9342*); Orick, Calif., Dec. 4 (*9386*); Trinidad, Dec. 6 (*9446*); Crescent City, Calif., Dec. 7 (*9500*-type); Olympic Hot Springs, Olympic National Park, Wash., Oct. 17, 1941 (*17,998*); Oct. 17 (*18,010*). Kauffman collected it at Lake Quinault, Wash., in 1925 and tentatively identified it as *Pholiota terrestris* Overholts.

Observations: *P. carbonaria* is closely related to *P. terrestris* but differs in its habitat, the color of the universal veil, and the size of the cystidia. *P. cruentata* Cooke & Smith should differ in having yellow gills at first and rubescent flesh. It is said to occur on burned areas also. *P. tuberculosa* sensu Bresadola has spores 7–9 × 4–5 μ and yellow gills, but is illustrated as having brightly colored scales somewhat like those of *P. carbonicola*. *P. carbonicola* was most abundant during the cold season of 1935, and fruited most abundantly after a hard freeze.

Pholiota Kauffmaniana sp. nov.

Pholiota flammans similis sed sapor mitis et pileus viscidus. Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Anderson Creek, Baker National Forest, Wash., Sept. 1, 1941, A. H. Smith *16, 268*.

Pileus (3) 4–8 (10) cm. broad, obtusely conic with an incurved sterile margin when young, becoming obtusely campanulate or plane with a low umbo, umbo sometimes obsolete, viscid to glutinous beneath a surface-covering of recurved fibrillose scales, somewhat glabrescent at least over the umbo or disc, margin decorated with submembranous patches of veil tissue, color "picric yellow" to "lemon-chrome" (very brilliant pale yellow) over all including the scales, becoming "amber-yellow" to "raw sienna" at least on the disc (bright yellowish tawny); flesh rather thick and firm, "picric-yellow" throughout or with a watery greenish yellow band next to the gills, odor and taste perfectly mild; lamellae "picric-yellow" but staining sordid brown along the edges when bruised, sharply adnexed, close to crowded, 3 tiers of lamellulae, moderately broad (up to ± 5 mm.), edges

even; stipe 4–9 cm. long, 5–8 (10) mm. thick, equal or nearly so, bright picric-yellow both inside and out, increasingly scaly upward with recurved fibrillose picric-yellow scales; annulus merely a superior zone of bright yellow fibrils or submembranous but evanescent; surface of stipe appressed fibrillose above annulus.

Spores ellipsoid, smooth, very minute, 4–5 × 2–2.5 μ, very pale under the microscope, rusty in mass; basidia four-spored; pleuro- and cheilocystidia similar and abundant, 22–30 × 7–9 μ, obtuse, subcylindric to submucronate or broadly fusoid-ventricose, content usually homogeneous, and yellow or brownish, sometimes hyaline and some with a highly refractive amorphous content, projecting slightly beyond the hymenium; gill trama regular except for the narrow subgelatinous interwoven subhymenium; pileus trama homogeneous beneath a thick gelatinous pellicle; numerous bundles of long needle-like crystals forming in or on the hymenium and trama of pileus and gills when revived in KOH.

Single to cespitose on conifer logs and debris, Grassy Patch, Great Smoky Mts. National Park, Tenn., Sept. 3, 1938 (*10,868*); Shuksan Inn, Wash., Aug. 15, 1941 (*16,161*), Aug. 14 (*16,186*); Anderson Creek, Baker National Forest, Aug. 19 (*16,268*); Timberline Camp, Mt. Baker, Wash., Aug. 24 (*16,339*); Baker Lake, Wash., Sept. 1, (*16,549*); Mt. Angeles, Olympic Mts., Wash., Sept. 26, 1941 (*17,342*). Kauffman made four collections at Lake Quinault, Wash., in 1925.

Observations: Kauffman recognized this fungus as a new species closely related to *P. flammans* (Fries) Quél. but differing particularly in its viscid pileus. The literature of *P. flammans* from the time of Fries down to the present is consistent in describing it as dry. Recent works such as those of Métrod (**1938**) and Lange (**1938**) also bear out this concept. Métrod in particular has given sufficient information on the European fungus to enable one to make a critical comparison with the species described here. Two characters stand out as sharply distinct, namely the viscid pileus and mild taste of *P. Kauffmaniana*. *Pholiota lucifer* differs from both of these in having larger spores. Although Overholts (**1927**) adhered to the tradition that *P. flammans* has a dry pileus, he referred to one collection at New York in which the collectors notes described the pileus as viscid.

The viscidity of the pileus can be demonstrated almost as

readily from dried as from fresh material. The pellicle of a viscid species gelatinizes appreciably and has a very characteristic appearance in either water-mounts of fresh material or in mounts of dried material revived in KOH. In Kauffman's collections from the Adirondack Mountains of New York, in one collection he made in Sweden, in his Colorado specimens, and in all of my collections from the Adirondacks, Nova Scotia, Ontario and Tennessee the pilei possess the thick gelatinous pellicle characteristic of a viscid species. The taste of these collections was not recorded, and they were all identified as *P. flammans*. Since the hyphae of the pellicle are very narrow (2.5–4 μ) and form a rather sharply differentiated layer between the scales on the surface and the main portion of the tramal body, it is doubtful if Métrod would have overlooked them in his study. Consequently, on the basis of Kauffman's collection from Sweden, it appears that *P. Kauffmaniana* occurs there as well as throughout the United States. The bundles of needle-like crystals which form in mounts of *P. Kauffmaniana* revived in KOH may be an additional distinguishing character.

Tricholoma atroviolaceum sp. nov.

Pileus 5–12 (14) cm. latus, obtusus vel umbonatus, siccus, atro-violaceus et squamulosus; odor et sapor farinaceus; lamellae confertae, sinuatae, latae, fumoso-avellaneae; stipes 6–14 cm. longus, 10–30 mm. crassus, solidus, subcinereus mox umbrinus, fibrillosus demum furfuraceus; sporae 7–9 × 3.5–6 μ. Specimen typicum in Herb. Univ. of Mich. conservatum: Legit A. H. Smith *8195* prope Kerby, Ore., Nov. 29, 1937.

Pileus 5–12 (14) cm. broad, obtuse and with a slightly incurved margin when young, becoming broadly umbonate or plane, the margin spreading or recurved somewhat in age and frequently plicate or splitting radially, surface dry and covered over all except the margin by minute recurved blackish violet scales, color blackish violet from the dense covering of fibrils ("dark grayish brown" over central part and "benzo brown" along the margin, darker in age); flesh thin but rigid and brittle (4–5 mm. near the stipe), sordid brownish gray to nearly "drab-gray," odor very strongly farinaceous, taste slightly to strongly farinaceous, no color change when cut or bruised but sometimes gradually darkening; lamellae close, 1–2 tiers of lamellulae, sinuate to adnexed, broad (up to 1 cm. ±), very brittle, "light cinnamon-drab," "light drab" or "wood-brown" (dull cinnamon overcast

with gray), edges uneven to eroded and usually staining blackish; stipe 6–14 cm. long, 10–30 mm. thick, equal to enlarged above or sometimes with an abruptly bulbous base, solid, tinged pale drab within, pallid at very first but soon tinged "benzo brown" and finally quite dark, surface appressed fibrillose and becoming somewhat furfuraceous at times from the broken cuticle (color darker when the fibrillose coating is dense).

Spores subellipsoid to subovoid, 7–9 × 4.5–6 μ, not amyloid; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama subregular, not or only very slightly amyloid; pileus trama pallid and homogeneous beneath a surface layer distinctly differentiated by the dark fuscous brown color of the cells, the pigment located on the wall as a very thin incrustation.

Gregarious under conifers, Oregon-California state line near Kerby, Ore., Nov. 29, 1937 (*8195*-type); scattered under conifers, Olympic Hot Springs, Olympic Mts., Wash., Oct. 2, 1941 (*17,539*), same locality Oct. 8 (*17,701*), Oct. 11 (*17,764*), Oct. 15 (*17,906*); Storm King Mountain, Olympic National Park, Oct. 16, 1941 (*17,971*); Mt. Angeles, Olympic Mountains, Wash., Oct. 20, 1941 (*18,063*).

Observations: *Tricholoma hordum* Fries *sensu* Ricken is described as having an almost violet-black pileus, but lacks a farinaceous odor and taste, has distinctly smaller spores, and apparently a paler stipe. Fries described *A. hordus* as cinereous as well as lacking a distinctive odor and taste, so my collections cannot be placed there. *Tricholoma elytroides* is also close but should be readily distinguished by its smaller spores and paler pilei. *T. pardinum sensu* Konrad and Maublanc is also close but readily distinct by its paler color. The lack of cheilocystidia distinguished *T. atroviolaceum* from such fungi as *T. atrosquamosum* and *T. squarrulosum*. *T. murinaceum sensu* Bresadola has a bitter then acrid taste, and apparently much paler colors.

Tricholoma aurantio-olivaceum sp. nov.

Pileus 1–3.5 cm. latus, conico-campanulatus, siccus, aurantio-fibrillosus demum obscure aurantius; lamellae confertae, latae, adnexae, ventricosae, pallidae, aurantio-maculatae dein olivaceo-cinereae; stipes 4–6 cm. longus, 3–5 mm. crassus, deorsum attenuatus, aurantio-fibrillosus, sursum aurantio-guttatus; sporae 5.5–7 × 3.5–4.5 μ.—Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Olympic Hot Springs, Olympic National Park, Wash., Oct. 8, 1941, A. H. Smith *17,666*.

Pileus 1–3.5 cm. broad, obtusely conic with an incurved margin, expanding to conic-campanulate or obtusely umbonate and with a spreading margin, surface dry and appressed fibrillose, young specimens with bright orange ("ochraceous orange") fibrils on a "cinnamon-buff" (buff) background, in age either yellowish over all or developing an avellaneous or sordid yellow-brown ("snuff-brown") cast, the colors becoming sordid in age; flesh thin except in the umbo (1.5–2.5 mm.), pallid, odor none, taste mild, unchanging when cut; lamellae close, 40–60 reach the stipe, 1–2 tiers of lamellulae, broadly and deeply adnexed, broad (5–6 mm.), ventricose near the stipe and tapered to the margin, white or "tilleul buff" (pallid) when young, gradually becoming pale cream-color and soon stained with pale orange-brown spots which darken to dark olivaceous, edges uneven but not eroded; stipe 4–6 cm. long, 3–5 mm. thick at the apex, narrowed downward to an almost pointed base, solid or with a stuffed tubule, surface covered with a thin coating of bright orange ("ochraceous orange") fibrils and the apex beaded with "ochraceous orange" droplets, the orange fibrils becoming sordid brownish in age, apex whitish, base soon stained orange-brown and finally olivaceous brown, the change gradually progressing upward.

Spores 5.5–7 × 3.5–4.5 μ, ellipsoid, smooth, not amyloid; basidia four-spored; pleurocystidia and cheilocystidia not differentiated; gill trama regular to subregular, not amyloid, cells 7–12 μ in dia. and cylindric, 20–100 μ long; pileus trama homogeneous, not amyloid, surface-hyphae with orange walls.

Densely gregarious under conifers, Olympic Hot Springs, Olympic National Park, Wash., Oct. 8, 1941 (*17,666*) and again Oct. 15 (*17,901*); Lake Mills, Olympic Mountains, Wash., Oct. 15, 1941 (*17,951*).

Observations: Kalchbrenner (1873) described *Agaricus psammopus* as having bright yellow gills and an acrid taste but did not mention a change in color of the gills when bruised or in age. Although Kalchbrenner's species is included in practically all the manuals of the European agaric flora, nowhere is it described as slender or with gills that stain olivaceous gray. Its stipe is usually described as 6–10 (18) mm. thick. Since weather conditions were very favorable for agarics around Olympic Hot Springs in the fall of 1941, the slender stature and small size of the carpophores collected there cannot be explained as being caused by unfavorable fruiting conditions. There is no larch in the region

where my collections were made. The only conifer common to all the localities was Douglas fir. In additon to habitat, color-change, and small size, there may be other significant differences between *T. psammopodium* and *T. aurantio-olivaceum*. The stipes in my collections were evenly fibrillose. The drops of fluid near the apex may leave slight stains in drying but do not cause the apex to appear granular. *T. psammopodium* was reported for the United States by Rea and Ramsbottom (**1929**). American mycologists have probably considered it as merely a form of *T. vaccinum*.

Tricholoma rhizoideum sp. nov.

Pileus 1–3 cm. latus, convexus, siccus, subfibrillosus, pallide avellaneus; lamellae adnatae vel subdecurrentes, angustae, subdistantes, pallide subincarnatae; stipes 3–5 cm. longus, 3–5 mm. crassus, deorsum attenuatus, intus subavellaneus, extus albido-fibrillosus, sursum furfuraceus; sporae 4–5 × 2–3 μ. —Specimen typicum legit A. H. Smith *18,107*, prope McKenzie Pass, Ore., Oct. 29, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 1–3 (4) cm. broad, broadly convex with an inrolled margin, becoming plane, surface dry and satiny from a thin white fibrillose coating, color evenly "pale vinaceous fawn" (very pale avellaneous), darker and more sordid vinaceous buff when surface fibrils have worn away; flesh thin but firm (1.5–2 mm.), equal; lamellae close to subdistant (32–36 reach the stipe, 1–2 tiers of lamellulae) "pale pinkish buff" to "pale pinkish cinnamon" or darker in age (pale buff or tinged flesh-color and in age sordid pale alutaceous); stipe 3–5 cm. long, 3–5 mm. thick at apex, narrowed below to a long flexuous pallid vinaceous rhizomorph, solid, flesh pallid vinaceous buff, surface white from a dense coating of white fibrils which cause apex to be more or less furfuraceous, glabrescent, a pallid sordid brownish color below, rhizomorphs and young individuals growing in dense masses throughout the soil but no sclerotia found.

Spores 4–5 × 2.5–3 μ, ellipsoid, smooth, not amyloid; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama of narrow interwoven hyphae, not amyloid; pileus trama homogeneous, not amyloid, surface hyphae interwoven, clamp connections present but rare.

Cespitose to subcespitose in the duff under conifers, possibly on the very decayed remains of an old fungus but evidence not positive. McKenzie Pass, Ore., Oct. 29, 1941 (*18,107*) and from Mt. Shasta, California, Wm. B. Cooke.

Observations: This species is very closely related to *Tricholoma sclerotoideum* Morse but readily distinguished by its small spores and lack of fleshy sclerotoid masses at the base of the stipe. At first I thought *T. rhizoideum* might be a gigantic form of *Collybia cirrhata*, but the more distant gills appear distinct along with other secondary characters such as size and gill-color. However, it appears that a rather distinct phylogenetic series of species exists here. *Collybia tuberosa*, *C. cirrhata*, *C. Cookei*, *C. racemosa* and *C. olympiana* though smaller are similar in general aspect to *T. sclerotoideum* and *T. rhizoideum*.

Tricholoma subumbrinum sp. nov.

Pileus 3–6 cm. latus, obtusus vel subumbonatus, viscidus, virgatus, disco sordide luteo-umbrinus, demum fuligineo-maculatus; odor et sapor valde farinaceus; lamellae subsinuatae, confertae, latae, pallidae demum umbrino-maculatae; stipes 9–12 cm. longus, 9–12 mm. crassus, pallidus, glaber vel subsquamulosus; sporae 7–8.5 × 4–5 μ.—Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Olympic Hot Springs, Olympic National Park, Wash., Oct. 8, 1941, A. H. Smith *17,671*.

Pileus 3–6 cm. broad, obtusely conic to subconvex, the margin inrolled at first, becoming plane or retaining a low subconic umbo, surface viscid but soon dry, pellicle not separable, glabrous or appearing streaked as if with appressed fibrils, the ground color "tilleul buff" (pallid) and most evident toward the margin, central portion "Saccardo's umber" or "sepia" (sordid yellowish brown), in age spotted "mummy brown" or finally nearly "drab" on the umbo; flesh thick and firm, tapering evenly to the margin, brittle, pallid to pale avellaneous, odor and taste very strongly farinaceous; lamellae close, subsinuate to adnexed, broad (5–8 mm.), becoming subventricose, white or pallid, edges usually staining sordid brown where injured and becoming sordid brownish spotted in age; stipe 9–12 cm. long, 9–12 mm. thick at apex, evenly enlarged to the base, soon hollow, pallid both inside and out, apex minutely fibrillose-furfuraceous, remainder glabrous or appressed fibrillose, slightly scaly in age and scales with a tendency to become sordid brownish.

Spores 7–8.5 × 4–5 μ smooth, ellipsoid, not amyloid; basidia four-spored, 30–36 × 7–8 μ; cheilocystidia and pleurocystidia not differentiated; gill trama of entangled more or less regularly arranged cells, not amyloid; pileus trama homogeneous beneath a thin gelatinous pellicle the narrow hyphae of which have sordid yellowish brown contents, remainder of tissue hyaline, not amyloid.

Scattered under conifers, Olympic Hot Springs, Olympic National Park, Wash., Oct. 8, 1941 (*17,671*-type) and (*17,690*), same locality Oct. 17, 1941 (*18,917*).

Observations: In collection *18,917* the older pilei were more or less fibrillose scaly. The species is very similar to *T. portentosum* but differs in its sordid yellowish brown color, slightly larger spores and the sordid brownish stains on the cap and gills. *T. subumbrinum* is not related to the reddish brown species with changing flesh and gills. *T. spermaticum sensu* Lange appears close to *T. subumbrinum* but its gills are not spotted and the colors as described and figured are too pale. *T. spermaticum* is generally considered to be a white fungus.

Tricholoma ionides var. **farinaceum** var. nov.

Sapor farinaceus; pileus demum vinaceo-lilacinus; sporae 4–5 × 2–3 μ. Specimen typicum in Herb. Univ. of Mich. conservatum: Legit Mrs. W. H. Burt et A. H. Smith *18,339*, prope Ann Arbor, Mich., June 13, 1942.

Pileus 2–5 (7) cm. broad, broadly convex young, soon expanded plane or the margin recurved and wavy, surface moist and glabrous at first, dull violaceous gray ("light benzo brown") on disc and nearly drab on the margin, fading as if subhygrophanous and then appearing unpolished or very finely silky, the colors changing to dull lilac over all ("purple-drab," "light vinaceous drab," "light vinaceous purple," "vinaceous lilac," "slate-violet" to "deep slate-violet"), sometimes becoming bright lilac-vinaceous; flesh whitish or flushed lilac near the cuticle, brittle, thin, odor and taste distinctly farinaceous; lamellae crowded, narrow (± 2 mm.) but finally becoming moderately broad, adnate or slightly emarginate with decurrent lines on the stipe, white but in age becoming slightly cream colored, edges soon becoming uneven or minutely eroded; stipe 3–5 cm. long, 3–7 (9) mm. thick, equal, hollow, elastic, surface thinly appressed fibrillose and more or less concolorous with the pileus, white strigose to mycelioid at base, rind cartilaginous to subcartilaginous.

Spores 4–5 × 2–3 μ, ellipsoid to ovoid, smooth, not amyloid, white in mass; basidia four-spored, 14–16 × 4–5 μ; cheilocystidia and pleurocystidia not differentiated; gill trama subparallel, the cells long and broad (50 × 6–10 μ); pileus trama homogeneous, the hyphae on the surface interwoven and with a dull lilac content, clamp connections not found.

Gregarious or single on soil in low grassy oak woods or along the borders of swamps, Cavanaugh Lake, Chelsea, Mich., Aug. 1,

1915, Kauffman; Whitmore Lake, Mich., July 11, 1929, A. H. Smith (notes by Kauffman), under elm, on muck at the edge of a bog; Howell, Mich., July 1, 1935, Smith *1446*; Burt's woods, Ann Arbor, Mich., under oak, June 13, 1942, Mrs. W. H. Burt and A. H. Smith *18,339*-type.

Observations: The sharpest distinction between typical material and the variety is the pronounced farinaceous taste of the latter, but there are other differences which appear to be more significant. The colors of the pilei are quite similar, but in the typical variety those of old pilei tend toward sordid grayish whereas in var. *farinaceum* they become brighter in age. Very old specimens have been examined and the gills never were found to be as yellowish as in var. *typicum*. For an account of the latter see Smith (**1941**). In his notes Kauffman had recognized var. *farinaceum* as a distinct species, apparently placing considerable emphasis on the slight difference in spore size and shape (4–5 × 2–3 μ as against 6–7 × 2–3 μ). My measurements for *T. ionides* var. *typicum* were 5–6 × 2–3 μ. Lange described *T. ionides* as having a somewhat farinaceous taste, yellowish gills and spores 5–6 × 2.7–3 μ. The difference in spore size is certainly not sufficient to justify describing a new species with it as the principle difference, and it appears that one can expect some variation in the taste. This is not in the least surprising. However, in the United States the information at hand indicates that the Michigan collections cited above are constant in the characters mentioned, and the differences cannot be regarded as seasonal variation.

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A WHITE VARIETY OF MUTINUS CANINUS [1]

S. M. ZELLER

(WITH 1 FIGURE)

Members of the Phallales are so uncommon in the Pacific Northwest that the occasional collection of one invokes considerable interest. In August 1942, button stages and mature specimens of a white *Mutinus* packed in soil in which they had grown were mailed to the Botany Department, Oregon State College. Some of the larger buttons about one inch long were planted (in a pot) in the soil in which they had originally grown. They were thoroughly soaked with water and placed in the moderately warm laboratory. By the next afternoon the fructifications had grown to full stature, as illustrated. It proved to be a variety of *M. caninus* (Pers.) Fries, pure white throughout except the gleba. Although this white form has previously been observed [2] it has been included under the typical form with the red colors in the receptaculum. This form is therefore designated as follows:

Mutinus caninus var. **albus** var. nov.

Button stages pure white; volva left at base of receptaculum as a 2–3-lobed clasping cup, outer coat (peridium) becoming sordid whitish, tinted cream, internally a light tan-colored gel, 2–3 mm. thick; receptaculum pure white to the apex, under the layer of olive spores, larger in diameter above than the stem-like portion below; hollow and chambered as in species; pileus (or outer membrane over gleba) white in young stages, practically obsolete at maturity, some brownish remnants, especially at lower margin of spore mass in fresh mature specimens; gleba odor foetid, deep olive (R) and darker; basidia typically phalloid, about 2–3 × 4–8 μ; 4–11-spored; spores light muddy olive, 3.5–4 × 1.8–2 μ.

[1] Published as Technical Paper No. 434 with the approval of the Director of the Oregon Agricultural Experiment Station, Corvallis. Contribution from the Department of Botany.

[2] Lloyd, C. G. Syn. Phalloids. Lloyd Lib. Bul. 13, 1909.

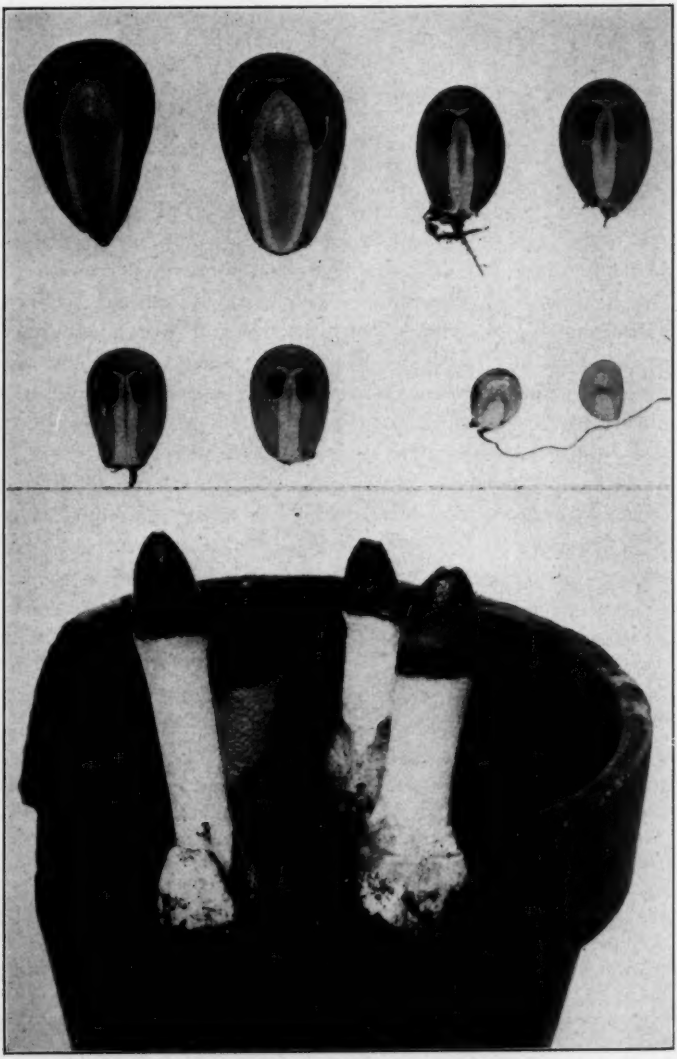


FIG. 1. *Mutinus caninus* var. *albus*.

In very sandy garden soil, Warrenton, Clatsop County, Oregon. Collected by *Maude D. Barlow*, Aug. 13, 1942.

The illustrations show (1) vertical sections of young button stages and (2) mature fructifications reared to maturity in the laboratory. In the sections of young specimens may be seen the pileus or outer sheath of the gleba as it breaks away from the apex of the stem (receptaculum). Burt,[3] dealing with the morphology of *Mutinus Ravenelii*, almost ignores this as remnants of a pileus, although in the summary he says that the formation of the sheaf-like head "reminds one of the changes that occur in the formation of the pileus in some of the Agaricinae." *Mutinus* is an instance where practically all of the fundamental pileate tissue is sloughed off with the volva in mature stages, leaving the gleba as a smear of spores and disintegrated tissue on the surface of the upper portion of the percurrent columella, stem, or receptaculum. To be entirely accurate the genus description should indicate "pileus lacking at maturity."

The photograph of mature specimens in a pot is presented to illustrate a method whereby unmolested fructifications of phalloids may be obtained for convenient observation or photographs.

[3] Burt, E. A. The development of *Mutinus caninus* (Huds.) Fr. Ann. Bot. **10**: 343–372, *illus.* 1896.

DEVELOPMENT OF THE PERITHECIUM IN ASPERGILLUS FISCHERI WEHMER, WITH A DESCRIPTION OF CROZIER FORMATION

LINDSAY S. OLIVE

(WITH 45 FIGURES)

INTRODUCTION

Aspergillus Fischeri Wehmer is one of three ascosporic species of *Aspergillus* recently obtained in our laboratory on tea leaves by Mrs. Ruth Ellis Allen. The writer obtained the fungus in culture from Mrs. Allen, whose paper surveying the three above-mentioned species is being prepared for publication. *Aspergillus Fischeri* Wehmer is an ascosporic species occurring in the *A. fumigatus* group. We are indebted to Dr. Kenneth Raper for the identification of this species.

The present paper describes the morphology and cytology of perithecial development in *Aspergillus Fischeri*, with a detailed account of crozier formation. Professor John N. Couch first discovered the presence of croziers in this fungus and found that he could best demonstrate them by dissecting the young perithecia under the microscope, rather than by preparing microtome sections. With this in mind, the writer has developed, and will later describe, a rather simple method for preparing slides for cytological study of crozier formation in *Aspergillus*. Apparently, croziers have been overlooked in many Ascomycetes because the investigator has relied too much upon sectioned material.

Dangeard (**3**), in 1907, described perithecial development in a species which he identified as *Aspergillus fumigatus* Fresenius, but did not observe crozier formation here. Since DeLamater (**4**) found that croziers were formed in *Arachniotus*, one of the lowest of the Euascomycetes, it is not at all surprising that they are found in *Aspergillus*. Emmons (**5**, **6**) has already reported

crozier formation in *Byssochlamys fulva* and in *Thielavia terricola* of the Aspergillaceae. DeLamater (**4**) has announced finding croziers in *Penicillium avellaneum*, but has not yet published on this species. Brefeld (**1**) illustrated for *Penicillium* groups of ascogenous hyphae with hook-like processes; yet he showed the asci in chains, as though they were produced by a budding process. Fraser and Chambers (**7**), in an investigation of *Aspergillus herbariorum*, and Satina (**9**), in a study of *Magnusia nitida*, showed asci arising from penultimate cells of hook-like structures, but did not follow this to the fusion of the tip cell with the stipe cell.

The present paper presents the first complete cytological account of crozier formation in the Aspergillaceae, and one of the primary purposes of this paper is to describe a simple technique which will prove useful in the cytological investigation of crozier formation in any Ascomycete with soft perithecia.

MATERIALS AND METHODS

The fungus was grown on three types of agar; namely, Czapek's solution agar and our No. 5 (20 gms. agar, 3 gms. maltose, 1 gm. meat peptone, to 1 liter of water) and F-13 (20 gms. agar, 1.5 gms. maltose, 0.04 gms. peptone, to 1 liter of water). Perithecia were formed on all three. On Czapek's solution agar, the growth of vegetative hyphae was too dense for the method of preparation employed here. With our No. 5 agar, there was still too great a production of vegetative hyphae and conidiophores. The best growth of perithecia with a minimum of vegetative growth was obtained on F-13 agar, which has very small quantities of sugar.

Slides showing conidiophores and ascogonial coils were prepared by smearing on the slide in a small drop of Haupt's gelatin some of the mycelium obtained from a culture about three days old. Young perithecia showing ascogenous hyphae within were best studied in sectioned material, while the croziers and young asci were by far most advantageously prepared by the smear technique. With this procedure large numbers of croziers and asci were mashed out of the perithecia and spread out on the slide by pressure exerted on a cover glass placed over the material. All stages from the first appearance of the croziers to the forma-

tion of ascospores were very well shown on slides prepared in this way.

Some of the material, particularly the ascogonial coils, was studied in aceto-carmine preparations. Several stages in crozier formation drawn from such preparations are shown in figures 1–5. However, most of the slides, after being prepared by the smear technique, were dipped directly into one of three killing fluids: formalin-acetic-alcohol solution, Navashin's chromic-acetic-formalin solution, and formalin-acetic-proprionic acid solution. Here they were left from 6–24 hours. All three of these solutions proved effective, but the first was used most frequently. The slides were then carried through the iron-alum haematoxylin staining technique already described by the writer (**8**) for staining nuclei in the basidia of *Gymnosporangium*. The only change was a lengthening of the staining time to 8–12 hours.

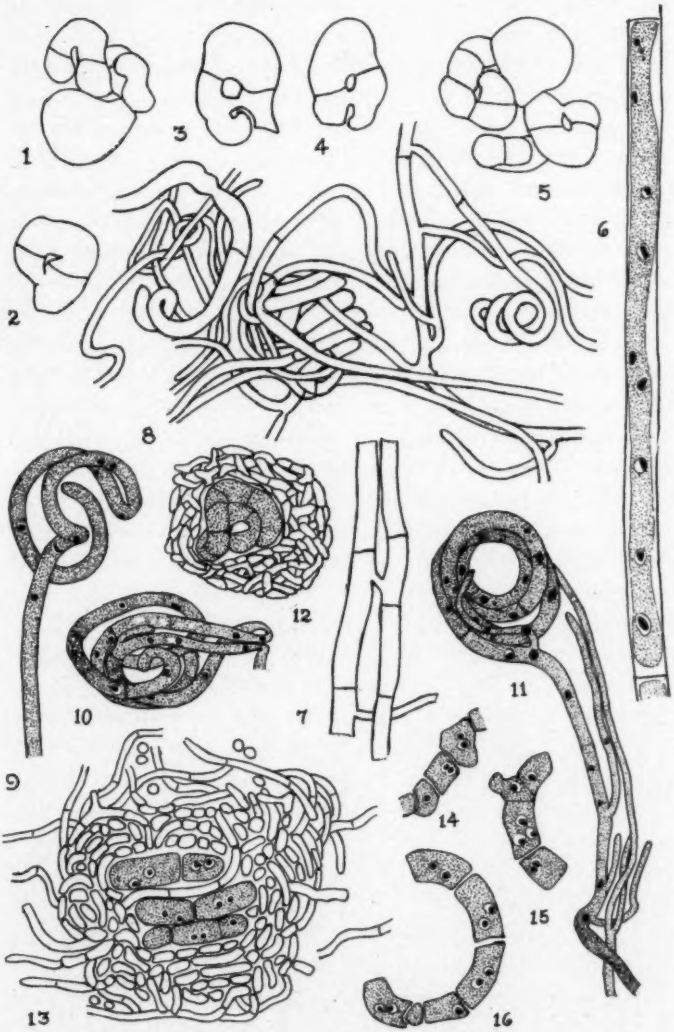
Some of the older perithecia were sectioned before staining, but it is very difficult to demonstrate croziers in this way; in fact, they are more likely to be overlooked entirely in sectioned material.

INVESTIGATIONS

From the time of transplanting a small portion of the mycelium of *Aspergillus Fischeri* onto an agar plate, mature perithecia are produced within a week. First to appear are the conidiophores and ascogonial coils. The former cease to be produced after 4 or 5 days growth on agar and eventually disappear entirely. The conidiophores, which are similar to those already described by Dangeard (**3**) for *Aspergillus fumigatus* Fresenius, will not be treated here.

Vegetative hyphae consist of long cells which are multinucleate (FIG. 6). Nuclei will be described later in connection with the development of the ascogonium. Fusions between vegetative hyphae are frequently observed in this species (FIG. 7).

Ascogonial coils become extremely abundant after about three days growth on agar. The tip of a young hypha extending from a larger hypha in the mycelium begins to coil (FIGS. 8, 9) and continues to do so until it has made from 4–8 turns (FIGS. 8, 10, 11). At first the young hypha is coenocytic, but when the coiling



FIGS. 1–16. *Aspergillus Fischeri* Wehmer.

has ceased, it becomes multiseptate, while the number of nuclei in each cell varies from one to several. At this time, other hyphae begin to grow towards the ascogonium from various points. Some of these hyphae are branches of the ascogonial coil itself (FIG. 10); some arise from the same hypha which gave rise to the coil (FIG. 11); while the majority probably grow in from neighboring hyphae (FIGS. 8, 11). All of these hyphae appear to be purely vegetative in nature. No branch which could be called an antheridium was observed here. Fusions between ascogonium and hyphae growing into the ascogonium were looked for by the writer, but none could be proven.

The growth of vegetative hyphae about the ascogonium eventually becomes so dense (FIG. 12) that it is necessary to section the material in order to observe the next stages of development. Sectioned material shows the coil imbedded in a dense mass of interwoven hyphae, and now the coil is composed of comparatively large cells, most of which are binucleate (FIGS. 13, 14, 16). Each nucleus consists of a dense inner body, the so-called nucleolus, surrounded by a clear area and that bounded by the nuclear membrane, which is not always distinct. The so-called nucleolus is a body which apparently includes, not only the nucleolus, but all of the chromatin in the nucleus as well. No chromatin network is seen outside the densely staining body at this time, and the latter is therefore probably homologous with the "endosphere" described by Savile (**10**) in unexpanded nuclei of the rust fungi.

Occasionally more than two nuclei are found in an ascogonial cell at this stage (FIG. 15). The end result, however, is a coil of binucleate cells. These cells, as Dangeard (**3**) has pointed out, appear to become dissociated; that is, although they remain in position for some time, there no longer seems to be any connecting cell walls between adjacent cells (FIGS. 13, 14, 16).

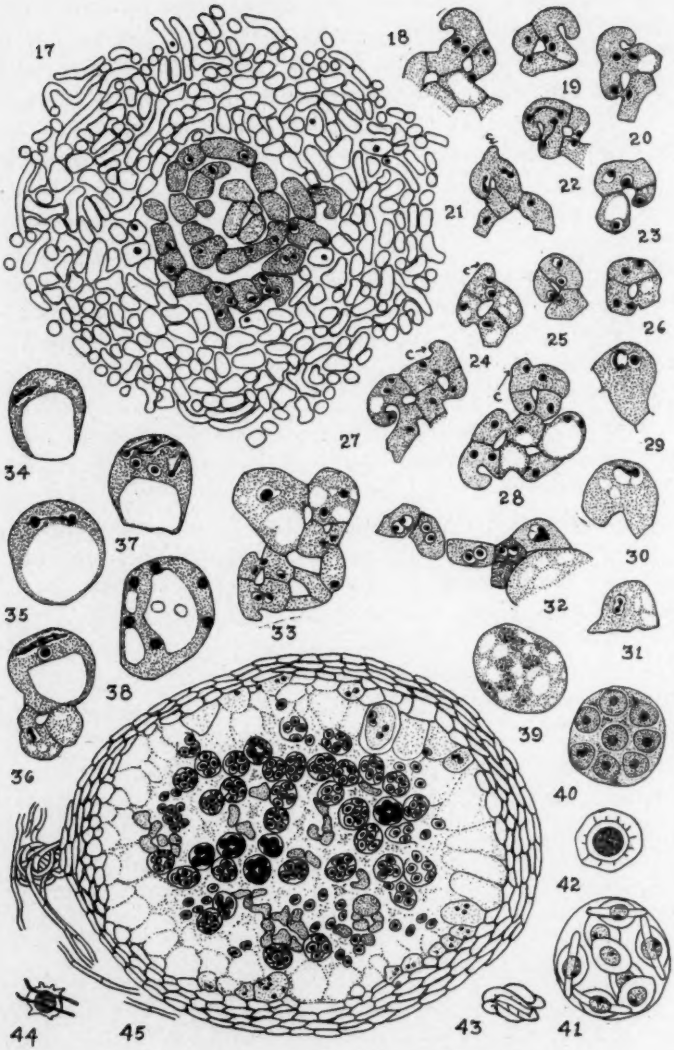
In a few instances it appeared that nuclei were fusing in pairs in some of the ascogonial cells (FIGS. 14, 15). If this is true and of common occurrence, it may be that we have a much reduced form of sexuality here, as Dale (**2**) has already described for *Aspergillus repens*. On the other hand, it must be admitted that

two nuclei of such small proportions when superimposed could easily be mistaken for fusing nuclei.

Sections through young perithecia at a slightly later stage show ascogenous hyphae beginning to bud out from cells of the coil (FIG. 17). Each bud apparently takes on the form of a crozier from the start, and further proliferation of the ascogenous branch takes place by a continuation of the crozier-forming process. The perithecium continues to increase in size during this development. The growth within is so prolific at this stage that, with a moderate amount of pressure on the perithecium, a great ball of closely packed ascogenous hyphae and croziers may be forced out intact. A slightly greater pressure will disperse these croziers in small groups over the slide so that they are more convenient for study.

The development of this mass of croziers is as follows. Any cell of the ascogonial hypha may produce a bud which hooks around in the form of a typical crozier (FIGS. 17–20). The two nuclei in the hook divide conjugately in planes almost at right angles to one another (FIGS. 21, 22). At the end of this division one nucleus passes into the tip of the crozier and a cross wall appears, cutting off a uninucleate tip. Another cross wall cuts off a stipe cell with a single nucleus, and the penultimate cell is left with a pair of daughter nuclei (FIG. 23). The tip cell of the crozier soon fuses with the stipe, and the nucleus in the latter passes into the crozier tip, thus bringing two daughter nuclei together in the tip cell (FIGS. 18, 24–26). While this development has been taking place, the penultimate cell has given rise to another crozier bud (FIGS. 24, 27, 28, *c*). This new crozier may begin to appear even before nuclear divison is completed in the one giving rise to it (FIG. 21, *c*). The binucleate crozier tip may also aid in this proliferation by forming a new crozier (FIGS. 3, 4).

When the ultimate growth of this mass of ascogenous hyphae has been reached, the penultimate cells of the croziers begin to enlarge, rather than form new croziers, and nuclear fusion takes place in each of these cells. These cells are the young asci. As the two nuclei come into contact prior to this fusion, their membranes break down. The nucleus at this stage still con-



FIGS. 17–45. *Aspergillus Fischeri* Wehmer.

sists of a deeply staining body, or endosphere, surrounded by a clear space in which no chromatin is visible. The two endospheres come into contact and fuse into one body, while a clear outer sphere persists around the latter (FIGS. 29–33). Frequently, one of the endospheres becomes elongated as fusion begins (FIGS. 29, 30).

By the time nuclear fusion is completed the ascus is generally considerably enlarged (FIG. 33). Through the coalescence of many smaller vacuoles, a single large vacuole appears near the center, so that the protoplasm is confined to the outer part of the ascus and next to the cell wall (FIGS. 33–38). It is thickest at the distal end of the ascus and this is where nuclear division occurs. The fusion nucleus now undergoes its first meiotic division (FIGS. 34, 35), then a second (FIG. 36), and a third division (FIG. 37), during which spindles appear. The result is an ascus with 8 nuclei (FIG. 38). In some manner a denser aggregation of protoplasm appears about each nucleus (FIG. 39), and this is followed by the appearance of a circular spore wall cutting out the nucleus with some of the surrounding protoplasm (FIG. 40). Some protoplasm is left on the outside of the 8 spores formed within the ascus. The mature ascus shows eight ascospores with conspicuous flanges on their outer walls (FIG. 41). Each spore contains a single nucleus. At maturity, however, no protoplasm is visible in the ascus outside the spores. There is some indication that the flanges on the ascospores are formed from the protoplasm which surrounded the spores just after the appearance of the circular spore walls (FIG. 40). Several mature ascospores were drawn in different views to demonstrate the nature of the flanges, which appear as two conspicuous bands surrounding the spore (FIGS. 42–44).

The perithecium, as it approaches maturity, is filled with asci. The inner wall of the perithecium is lined with large pseudo-parenchyma cells which are disintegrating (FIG. 45). Croziers are very rare or entirely absent at this time. The outer wall of the perithecium is a compact rind made up of small cells and is 3–5 cells in thickness. Eventually all of the larger pseudo-parenchyma cells on the inside of the perithecium disintegrate.

The walls of the asci break open, and the ascospores are freed into the cavity of the perithecium (FIG. 45).

SUMMARY

1. A morphological and cytological investigation of perithecial development in *Aspergillus Fischeri* Wehmer reveals that the perithecia have their origin in the numerous ascogonial coils which appear after a few days growth on agar. These coils become septate and invested with a compact growth of vegetative hyphae. No antheridia are found here.

2. The ascogonial coil in the young perithecium eventually becomes divided into binucleate cells which bud out to form the ascogenous hyphae.

3. Ascogenous hyphae proliferate greatly by means of crozier formation, while the perithecium increases in size.

4. Towards the end of this period of proliferation, the penultimate cells of the croziers enlarge to form asci. The two nuclei in each of the young asci fuse. This is followed by three karyokinetic divisions which result in an 8-nucleate ascus. Eight ascospores are cut out around these nuclei. The mature ascospore is uninucleate and has two conspicuous flanges surrounding it.

5. The mature perithecium is filled with asci whose walls eventually disintegrate and liberate their spores into the perithecial cavity.

ACKNOWLEDGMENT

The writer is grateful to Professor John N. Couch for his assistance during the course of this study and to Mrs. Ruth Ellis Allen, who furnished the specimens of *Aspergillus Fischeri* for culture and investigation.

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EXPLANATION OF FIGURES

(All figures × 1495, except where indicated.)

FIGS. 1–45. *Aspergillus Fischeri* Wehmer. 1–5, croziers and young asci pressed out of a perithecium, untreated; 6, single cell of a hypha stained to show nuclei, × 1015; 7, hyphal fusion, × 665; 8, ascogonial coils and adjacent hyphae, from aceto-carmine preparation, × 1015; 9, young non-septate ascogonial coil; 10, 11, septate ascogonial coils, showing origin of vegetative hyphae forming perithecial wall; 12, enlarged ascogonial coil surrounded by interwoven vegetative hyphae, × 1015; 13, young perithecia showing ascogonium with binucleate cells; 14–16, portions of ascogonia, showing tendency of cells to dissociate; 17, young perithecium with ascogonium giving rise to ascogenous branches in the form of croziers; 18–28, steps in crozier development, some figures showing formation of new crozier buds (c) from penultimate cells; 29–33, nuclear fusion in the young asci; 34, 35, first meiotic division in the ascus; 36, second division, one nucleus not yet undergoing division; 37, third division; 38, 8-nucleate ascus; 39, 40, appearance of the ascospores; 41, mature ascus; 42–44, ascospores in various views; 45, mature perithecium, × 443.

A NEW SPECIES OF CRINIPELLIS FROM OHIO

ALEXANDER H. SMITH AND MAURICE B. WALTERS

(WITH 1 FIGURE)

Crinipellis maxima sp. nov.

Pileus 2–4 cm. latus, obtusus demum late campanulatus vel plano-umbonatus, subzonatus, siccus, fibrillosus, fuscus, ad marginem sordide luteo-fuscus; lamellae albidae adnatae, confertae; stipes 4–6 cm. longus, 3–5 mm. crassus, aequalis, subradicatus, fusco-tomentosus; sporae 8–10 (11) × 4–5.5 μ; cheilocystidia 42–66 × 9–13 μ.—Specimen typicum in Herb. Univ. of Mich. et Farlow Herb., Harvard Univ. conservatum: Legit Maurice B. Walters, prope Cleveland, Ohio, Aug. 25, 1943.

Pileus 2–4 cm. broad, obtuse when young, the margin incurved and the disc flattened, becoming broadly campanulate to plano-umbonate, the disc abruptly depressed, somewhat zonate around the disc by concentric depressed lines, surface dry, appressed-fibrillose or fibrils arranged in appressed fascicles, disc unpolished as well as tuberculate and cinereous, area surrounding the disc "fuscous" or slightly paler (dark grayish brown), "bister" (dark yellowish brown) over the marginal area; flesh thin, white, pliant, reviving well, odor and taste not recorded; lamellae white, narrowly adnate, seceding, close to crowded, ventricose, edges white-fimbriate; stipe 4–6 cm. long, 3–5 mm. thick, equal, the base somewhat fusiform and tapered to a point or with a short pseudorhiza, pallid beneath a dense tomentose coating of umber fibrils or the fibrils tufted and giving a somewhat tomentose-scaly appearance, pallid within.

Spores 8–10 (11) × 4–5.5 μ, smooth, hyaline, narrowly ellipsoid, many pseudo-amyloid in age; basidia 28–33 × 7–8 μ, four-spored, hyaline in KOH; cheilocystidia abundant, hyaline, thin-walled, 42–66 × 9–13 μ, fusoid ventricose at first, the apex becoming elongated to a flexuous, filamentose but rarely branched proliferation 2–3.5 in dia.; pleurocystidia found only near the gill edge and similar to cheilocystidia; gill trama hyaline in KOH, dark rusty brown in iodine, central strand of somewhat interwoven elongated thin-walled cells 10–14 in dia., appearing cellular in section toward the subhymenium; pileus trama with the central body of hyaline thin-walled hyphae (4) 6–12 in dia., rather compactly interwoven and becoming dark reddish brown

in iodine; the cuticle of the pileus consisting of long acutely pointed thick-walled hairs which are flexuous to contorted over the basal portion but gradually even out to the acute apex, 4–7 μ in dia., 300 μ or more long, either aseptate or with numerous

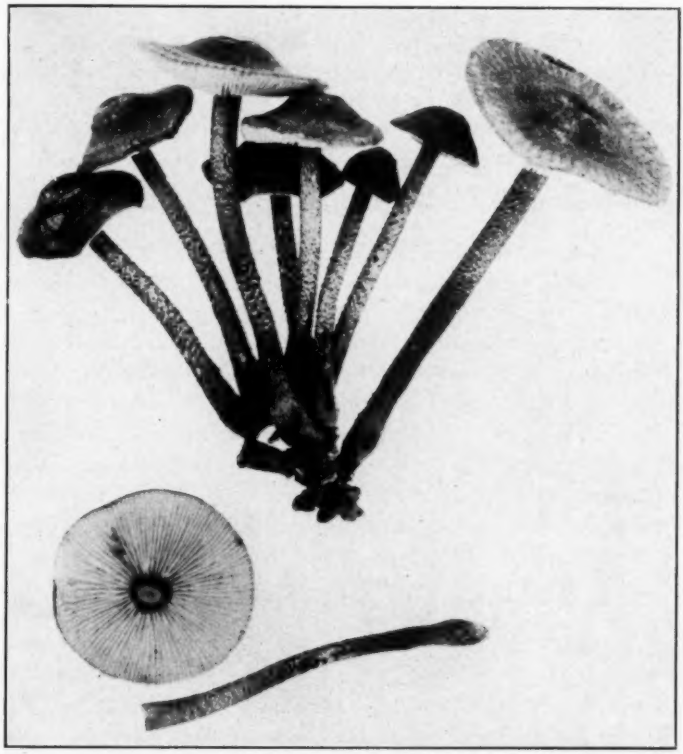

FIG. 1. *Crinipellis maxima* Smith and Walters, × 1.

secondary septae within 50–100 μ of the apex, the walls dark reddish brown in iodine, pale yellowish in KOH, and with clamp connections at the basal septae.

Cespitose in a brook-bed in mud and shale fragments, near Cleveland, Ohio, Aug. 25, 1943, collected by Maurice B. Walters.

Observations: The identification of the known species of *Crinipellis* has finally been placed on a scientific basis as the result

of the work of Singer.[1] As frequently happens when such a publication appears, and it is possible for other mycologists to critically evaluate their collections, interesting results are obtained. In this instance the first species to come to our attention was found to be undescribed. As a final check, material of the Ohio collection was sent to Dr. Singer for examination. He verified our opinion that the fungus was undescribed, but closely related to *C. hirticeps* (Peck) Singer. The outstanding character of the fungus, and the one emphasized by Dr. Singer in his letter, is the shape of the cheilocystidia. Since the fungus differs from *C. hirticeps* in other characters as well, we have described it as a species rather than as a variety of Peck's species. Habitat is an important character in *Crinipellis*, and to say the least, the habitat of *C. maxima* is peculiar, although more observations are needed to verify that the fungus is not typically lignicolous. Although the cluster was found growing in a mixture of shale fragments and the clay-like mud into which the shale disintegrates, it was actually very close to the root-tangled bank and the mycelium could easily have been attached to rotting roots. The brook bed was in the bottom of a ravine heavily wooded with a mixture of deciduous trees. Figure 1 shows the manner in which the carpophores develop from the mycelial strands.

ANN ARBOR, MICHIGAN

[1] A monographic study of the genera *Crinipellis* and *Chaetocalathus*. De Lilloa **8**: 441–534. 1942.

NOMENCLATURE OF FUNGI

G. R. Bisby

Everyone who uses scientific names may be affected by rules of nomenclature. Mycologists get along surprisingly well with their nomenclature, considering the small amount of effort most of them have given to the formulation of rules for their guidance. A review of some of their nomenclatural problems, and suggestions for a few possible interpretations, revisions, or additions to the rules may, it is hoped, prove useful for discussion; especially since the adoption in 1930 of the type method necessitates reconsideration of much past procedure.

The International Rules of Botanical Nomenclature, first adopted at Vienna in 1905, were based on de Candolle's "Lois" of 1867. These rules covered many of the fundamental problems of nomenclature of all plants. Fungi were not specifically considered. The Brussels Congress in 1910 revised the rules and added (evidently from proposals by Saccardo (**1**), who did much to keep mycological nomenclature on a fairly even keel, and by a group of American mycologists (**2**)) the articles now numbered 57 and 20, and three or four recommendations, all applying definitely to fungi. This second edition of the rules, published 1912, was followed by the third (the present) edition printed in 1935 which, as regards fungi, has practically no change from the second except the addition of Recommendations VI and VII and a list of proposed *nomina generica conservanda*. The Congress at Amsterdam in 1935 did not pass alterations specifically affecting nomenclature of fungi.

Meanwhile certain American workers had done valuable work for nomenclature in developing the "American Code."

Mycologists could, if they wished, formulate their own rules of nomenclature (as was recommended by a number of botanists at Vienna), but I presume the majority would now vote to continue to follow, after emendation, the rules used by other botanists.

Nomenclature cannot answer questions of taxonomy. Though it aims at fixity of names, the avoidance of error, of ambiguity, and of useless creation of names, it must recognize that an author is at liberty to combine generic names and specific epithets, or to propose families or orders, in any way that seems best to him. If, inadvertently or deliberately, he breaks the rules others who follow them—the majority of mycologists—will correct his nomenclature or ignore his work.

The rules do not attempt to obviate the use of judgment; on the contrary, the suggestion is made that their spirit rather than their letter should be followed: "In the absence of any relevant rule, or where the consequences of rules are doubtful, established custom must be followed." This is one of the principles upon which the rules are based.

At the present time there are two important rules concerning which differences of opinion obtain. The first is Article 57 dealing with the nomenclature of the different "successive states" of a species and the second is Article 20f regarding the starting points of the various groups. In the following paragraphs I venture to outline my personal views on these articles in the hope that they will help to clarify the situation.

SPECIES, STATES, AND ARTICLE 57. "Names of species are binary combinations consisting of the name of the genus followed by a single specific epithet" (Art. 27). Nomenclature does not presume to say what shall constitute a species, except that its name should have a type specimen or preparation, though a description or figure may suffice. The rules also recognize that, in fungi, names are often given to imperfect states.

A state of a species of fungi is imperfect or perfect. An imperfect state may be a mycelial, a spermogonial, a pycnidial, or other conidial state. The perfect state is that which produces basidiospores, ascospores, zygospores, or oöspores, together with associated structures which protect these spores.

"Stage" is commonly used as a synonym of "state," but "stage" involves an idea of regular succession, whereas states of fungi may occur simultaneously or in varying order.

Let us consider a few examples.

1. Most fungi have mycelium. This vegetative state is seldom named unless it has distinctive mycelial structures; then, if it seems advisable, the state can be considered to represent a species pending further information, given a binomial which has the same rules and rights as any other binomial, and the name classified in the Mycelia Sterilia of the Fungi Imperfecti. Examples: *Sclerotium durum* Fries,[1] *Rhizoctonia Crocorum* Fries.

2. A fungus may have a spore-producing imperfect state (and generally mycelium also, though this may not be evident unless the fungus is grown in culture). This state is usually self-perpetuating and, if it is the only one known, it needs and gets a binomial. This name also represents a good species of the Fungi Imperfecti, at least *pro tem.*

Mycologists formerly assumed that the large group of Fungi Imperfecti would gradually disappear through the discovery of perfect states, and considered that each species then should bear only one name, that of the perfect state: the rules still say "generic and specific names given to other states have only a temporary value." Mycologists now realize, however, that the temporary value commonly becomes permanent. It has become "established custom" to continue to use the name of an imperfect state, after its perfect state is demonstrated, if this be necessary or desirable in order to avoid ambiguity. Thus *Helicobasidium purpureum* Pat. has been shown to be the perfect state of *Rhizoctonia Crocorum;* but the latter binomial may, so far as known, represent the species in various regions or examples. Its use obviates the circumlocution "*H. purpureum* Pat., stat. mycel. steril." Furthermore, it may not be certain that *H. purpureum* represents the perfect state of *all* that passes under the name of *R. Crocorum.* In order to recognize these facts, it seems better to say that the "name applied to the . . . perfect form shall take precedence," as was proposed in 1910 (**2**). It will also be understood that the type specimen of *R. Crocorum* could be

[1] Or *S. durum* Pers. ex Fr. Pre-Friesian (and other pre-valid) authors and names are here omitted, just as Phanerogamists generally omit pre-Linnaean. In formal taxonomic treatises, especially if a specimen of Persoon's had been found or chosen as type, "Pers. ex Fr." would be more explanatory and accurate.

designated the type of its *Helicobasidium* only if it were definitely found to bear that perfect state.

3. A species having a named mycelial state (*e.g. Sclerotium durum*) may prove to have also a conidial state (*Botrytis cinerea* Fries). Both belong to the Fungi Imperfecti, but a spore-producing state is generally recognized as "higher" than (*i.e.*, takes precedence over) a mycelial state, and, as it became clear that both are regularly associated, the name *S. durum* rightly fell out of common use. Though the rules do not (and probably cannot) provide for the extinction of a binomial, the name *S. durum* should be used only in exceptional instances (say in a monograph of *Sclerotium*) for the name of a state of a species. But it seems most unlikely that *B. cinerea* will in turn be so nearly completely superseded by the name of its supposed perfect state, *Sclerotinia Fuckeliana* (de Bary) Fuckel.

4. A species may be known as a perfect state (and generally mycelium) only. An un-named conidial state found later must not, according to the present rules, receive a binomial in the Fungi Imperfecti. "Established custom"—a Principle—sometimes overrides this rule, but should do so only when distinct advantage is gained. If it be demonstrated that a conidial state with a prior name belongs to a species with a named perfect state, the rules say that one cannot legally propose a new combination and the type method makes this impossible unless the type specimen of the imperfect state also bears the perfect. In the Uredinales, however, the usual practice is to accept *Uredo* names as having equal status with names applied to telia. Arthur and others hold that is is legal because the uredo state is part of the perfect state.

5. A perfect state may be demonstrated for a species previously known only as a named imperfect state. According to my reading of the present rules, the "temporary value" of the latter name would end when the perfect state was described and named, the type specimen of the specific name would be that of the perfect state, and the name of the imperfect state should be dropped or cited only as a synonym. If, for example, a perfect state is described and named "*Mycosphaerella Aleuritidis* (Miyake) Ou (1940), syn. [the imperfect state] *Cercospora Aleuritidis* Miyake

(1912)" I take it that the binomial should be cited "*M. Aleuritidis* Ou (1940)," since the type specimen of the name of a *Cercospora* cannot (or at least should not) be made the type specimen of the name of a *Mycosphaerella* unless the specimen is shown to bear the perfect state. Once more, however, a wording that "the name of the perfect state takes precedence" should legalize the retention, when advisable, of the binomial *C. Aleuritidis* for the imperfect state.

6. A few species (*e.g.*, of *Aspergillus* and *Penicillium*) have perfect and imperfect states, but a name for the imperfect state only. This usage fulfils the principle of "avoidance of all useless creation of names," but if continued perhaps should be regularized by conserving the generic name (or redefining the genus) to include the perfect state.

These numbered paragraphs apply to Fungi Imperfecti on the one hand, to Basidiomycetes and especially Ascomycetes on the other. But the imperfect states of Phycomycetes—commonly more important or distinctive than the perfect state, if that be produced—are seldom classified in the Fungi Imperfecti. It is "established custom" to accept the first valid epithet or generic name applied to either state of a Phycomycete, and Article 57 does not forbid this custom for Phycomycetes. The custom could not now be changed without introducing much uncertainty as to names and authors of numerous Phycomycetes (**3**, **4**).

The re-wording of Article 57 should depend largely upon the views of the majority of mycologists upon such examples and principles as are given above. I suggest this for your criticism:

57. In Ascomycetes and Basidiomycetes (but not Phycomycetes) with pleomorphic life-cycle, the first valid name or epithet applied to the perfect state (that producing asci or basidia, together with the appropriate associated structures; in Uredinales, to the *Uredo* or telial stage) takes precedence. Similarly, the name or epithet of a spore-producing state takes precedence over that applied to a mycelial state. The type specimen of a state must bear that state. The author who first describes a perfect state is at liberty to use the specific epithet of the imperfect state, but his binomial of the perfect state is to be attributed to him alone.

ARTICLE 20F. Various interpretations can be given to the words "Legitimate botanical nomenclature begins for Fungi caeteri [Eumycetes, excluding Uredinales, Ustilaginales, and Gasteromycetes] at 1821–32 (Fries, *Systema mycologicum*)." The American proposal (**2**) stated: "we are in favour of adopting Fries's *Systema* in view of the fact that it includes a much larger number [than Persoon's *Synopsis*] of widely distributed genera and species." From this, and from experience, I gather that validation was intended to apply, and should apply, mainly to specific epithets and generic names. Please criticize this procedure: given a pre-*Systema* binomial, start with the epithet. If found (say *via* the Index of vol. III, under any generic name) accepted in *Systema* vol. I (1821), vol. II (1822 or 1823), or vol. III (1829 or 1832), consider the epithet validated by that acceptance and at that date, regardless of the group in which Fries placed it (**5**, **6**, **7**, **8**). Similarly, but secondarily, proceed with the generic name. Pay attention to "validation" by Fries of higher groups only in this sense: an epithet or generic name not included in the *Systema* is not in need of validation if published after Fries had dealt with the genus or higher group to which it belongs; *e.g.*, all epithets of *Agaricus*, and most epithets and generic names of other Hymenomycetes, are "post-*Systema*" if published after Jan. 1, 1821; but most Hyphomycetes remain "pre-*Systema*" until after 1832. As for *Elenchus* I and II (both 1828), I give it no more "priority" than any other work of the same date (but see **10**). It is true that Fries cites his *Elenchus* in the Index to the *Systema*; but he also cites references to *Linnaea*.

OTHER COMMENT. The American proposal of 1910 (**2**) recommended: "The subdivisions, or 'tribes,' of *Agaricus* used by Fries in his Systema Mycologicum are to be treated as having been employed as genera at the time of publication of this work." This was not adopted at Brussels, but was proposed anew by Dodge in 1934 (**9**). Dodge's proposal was not adopted at Amsterdam, but is still before Congress, so that one may now cite names and authorities of agarics either way. It is evident that mycologists, particularly those dealing with taxonomy of Agaricaceae, should give this proposal their considered opinion. I believe that phanerogamists would (or at least should) not

outvote mycologists if the latter can present the view of the majority.

Likewise, though proposals for *nomina specifica conservanda* have been rejected by Congress, I (**3, 4**) am anxious to know and to accept the verdict of the majority of mycologists on such a proposal for names of fungi. Let us take steps to ascertain that verdict.

There is no objective test for "right and wrong" in nomenclature. The rules can be enforced only so far as they are "used by the great majority of botanists in all countries" (Art. 1). Let us have thought, discussion, and considered opinion on proposed amendments. It seems to me that mycologists—at least, as a start, in English-speaking parts of the world—should be able to come to an agreement on most of the points at issue over rules of nomenclature. But all that I have written above gives merely my own views (at present), and is offered for your criticism.

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FUNGI OF THE NORTHWESTERN HIMALAYAS: USTILAGINALES

B. B. MUNDKUR

(WITH 1 FIGURE)

The fungi on which this report is based were collected in North Western Himalayas by Dr. R. C. Stewart and Mrs. I. D. Stewart. The smut collections consisted of 21 specimens, of which two have been found to be new species and five are new records for India. Three specimens are portions of smuts sent by Dr. Stewart to Dr. G. P. Clinton of Yale University some years ago, two of them being on *Polygonum* spp. and the third on *Andropogon annulatus*, a grass now known by the binomial *Dicanthium annulatum* (Forsk.) Stapf. All three specimens were named *Ustilago utriculosa* (Nees) Tulasne by Clinton and Zundel (**1938**). The smut on the grass is undoubtedly *Sphacelotheca annulata* (Ellis & Ev.) Mundkur. As for the other two smuts identified as *Ustilago utriculosa*, this is a collective species which has been critically studied by Liro (**1924**) who has segregated it into a number of species on distinct morphological characters. One of the specimens on *Polygonum* agrees with *Ustilago Cordai* Liro and the other on a similar host with *Ustilago reticulata* Liro. These identifications have been confirmed by a comparison with Sydow's Ustilagineen nos. *168* and *59*, respectively, which are cited by Liro (**1924**) as representing his concept of these species.

Among the collections is a smut on *Grewia villosa*, remarkable for the fact that it occurs on the stems of a woody plant. Its characters agree in all respects with the genus *Xylosorium*, recently proposed by Zundel (**1939**) for a smut on another woody plant, *Piper* sp. Comparison with *Ustilago Grewiae* (Passer.) Hennings, received from the Mycological Herb. Royal Bot. Garden, Peradineya, Ceylon, indicates that both are one and the same species.

The genus *Xylosorium* was established by Zundel (**1939**) for the reception of a smut occurring on the stems of a woody plant,

with 3–4 septate pustules that are covered by a hard coriaeceous membrane which ruptures irregularly at maturity, disclosing a dark-brown, semi-agglutinated spore mass, the spore balls disintegrating into single spores at maturity. It will be noted that the characters in which it differs from *Ustilago* are, principally, the locular pustules and the hard coriaceous layer enclosing them. As for the semi-agglutinated spore mass and the spore balls that disintegrate at maturity, the immature sori of several species of *Ustilago* also show such characters.

However if the other characters enumerated above justify the establishment of a separate genus, then the logical name that should be applied to it is *Pericladium*, proposed by Passerini in 1875 for accommodating the smut on *Grewia*. Passerini (**1875**) thought that his monotypic genus *Pericladium* belonged to the Uredinales but Hennings (**1900**) showed that the fungus is a smut and transferred it to the genus *Ustilago*.

I consider that both this smut and the smut on *Piper* sp. from Transvaal, deserve a place in a separate smut genus because of the peculiarities noted above. The name *Pericladium* of Passerini (**1875**), which precedes the name *Xylosorium* proposed by Zundel (**1939**), is accordingly transferred from the Uredinales to the Ustilaginales, a procedure which is permissible, as it involves only a question of interpretation of a structure; Zundel's *Xylosorium* thus becomes a synonym.

The spores of the *Grewia* smut in the Stewart collection were (18–4–1938) viable and they germinated by the formation of a septate promycelium. This shows that the position of the genus *Pericladium* is in the Ustilaginaceae. Zundel's *Xylosorium Piperii*, portion of the type collection of which was kindly sent to me by Dr. E. M. Doidge of Transvaal, is renamed *Pericladium Piperii* (Zundel) Mundkur, comb. nov.

New records are preceded in this report by an asterisk (*) and new species and new combinations are in bold face type; new hosts are preceded by two asterisks (**).

It gives me very great pleasure to place on record my deepest gratitude to Dr. R. R. Stewart and his wife, Mrs. I. D. Stewart, for placing their collections at my disposal for identification. Very few botanists in India have collected fungi so extensively

as they have done and their collections have immensely enriched our knowledge of the Indian fungi, and incidentally helped in make more representative the *Herb. Crypt. Ind. Orient.* of this Institute. Portions of specimens have also been placed in the

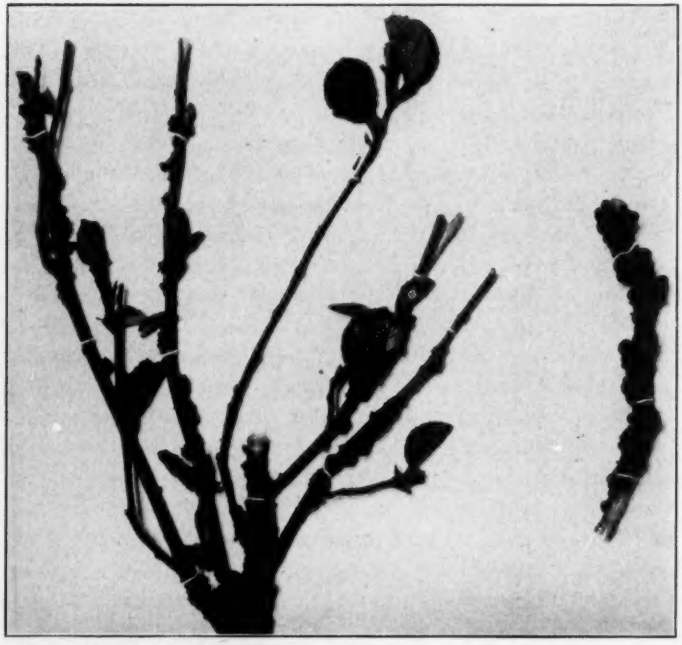

FIG. 1. Left, *Pericladium Grewiae;* right, *P. Piperii.*

mycological herbarium of The New York Botanical Garden by Dr. Stewart. My thanks are due to Rev. Dr. H. Santapau, S. J., Professor of Botany, St. Xavier's College, Bombay, for the latin translations of the diagnoses of new species.

USTILAGINACEAE

1. *USTILAGO CORDAI Liro, Die Ustilagineen Finnlands I, p. 12. 1921.

   Syn. *Ustilago utricolosa* Clinton & Zundel [*nec* (Nees) Tulasne], Mycologia **30**: 280. 1938.

On *Polygonum* sp.; Kangan-Gund (Kashmir, 6000 ft.), Sept. 7, 1922, *No. 7536.*

2. USTILAGO CYNODONTIS P. Henn. Engler's Bot. Jahrb. **14**: 369. 1891.

On *Cynodon Dactylon* (L.) Pers. Bandipur (Kashmir, 5000 ft.) July 18, 1940, *No. 19422.*

3. USTILAGO HORDEI (Pers.) Lagerheim, Mitt. Badischen Bot. Ver. p. 70. 1889.

On *Hordeum vulgare* L. Sonamarg, Sind Valley (Kashmir, 9400 ft.), Aug. 31, 1940, *No. 21283* (with *U. nuda*).

4. USTILACO NUDA (Jensen) Rostrup, Tidsskr. Landökonomi **8**: 745. 1889.

On *Hordeum vulgare* L. Skardu, Baltistan (Kashmir, 11,000 ft.), Aug. 5, 1940; above Sonamarg, Sind Valley (Kashmir, 9400 ft.), Aug. 31, 1940, *No. 21283.*

5. *USTILAGO RETICULATA Liro, Die Ustilagineen Finnlands I, p. 20. 1921.

Syn. *Ustilago utriculosa* Clinton & Zundel [*nec* (Nees) Tulasne], Mycologia **30**: 280. 1938.

On *Polygonum* sp. Pahlgam (Kashmir, 7300 ft.), Sept. 14, 1920, *No. 5801* (the date cited by Clinton and Zundel (l.c.) is incorrect).

6. USTILAGO TRITICI (Pers.) Jensen, in Kellerman and Swingle, Ann. Rep. Kansas Agric. Exp. Sta. **2**: 262. 1890.

On *Triticum vulgare* Host, Baltistan (Kashmir, 10,000 ft.), Aug. 15, 1940.

7. SPHACELOTHECA ANNULATA (Ellis & Ev.) Mundkur, Trans. Brit. Myc. Soc. **23**: 92. 1939.

Syn. *Ustilago utriculosa* Clinton & Zundel [*nec* (Nees) Tulasne], Mycologia **30**: 280. 1938.

On *Dicanthium annulatum* (Forsk.) Stapf, Pathankot (Punjab plains), May 11, 1917, *No. 1776.*

8. SPHACELOTHECA CRUENTA (Kuehn) Potter, Phytopathology **2**: 98. 1912.

On *Sorghum halepense* Pers. Sialkot, Sept. 9. 1935, *No. 15034.*

9. SPHACELOTHECA SCHOENANTHI (Syd. & Butler) Zundel, Mycologia **22**: 136. 1930.

On** *Cymbopogon schoenanthus* (L.) Spreng., Hassan Abdal (Attock Dt.), April 1934, *No. 13876A;* Margalla (Rawalpindi Dt.), May 1934, *No. 13882.*

10. ***Sphacelotheca Stewartii** Mundkur, sp. nov.

Ovaricola. Sori ad 10 × 5–8 mm., primo membrana firma, persistente, falsa circumdati, deinde dehiscentes in apice et patefacientes sporarum massas aureobrunneas; columella prominens, apice furcato. Sporae in laxis globulis qui cito degenerant atque evadunt pulverulenti; sporae "snuff brown" (Ridgway), globosae, subglobosae vel ellipsoideae, nonnullae tenuiter angulares, magnitudinis 7.4–13.0 μ diam. medietate 10.4 μ; epispora relative minus densa, superficie minute sed prominenter excavata vel punctata; germinatio per septatum promycelium terminaliter atque lateraliter sporidiis ornatum.

Typus lectus a R. R. Stewart (*No. 20793*) super Penniseto flaccido Griseb. in loco Baltistan (in via ex Kasurmik ad Doghani, Kashmir) die 16 Augusti 1940; ab eodem R. R. Stewart (*No. 21140*) iterum lectus in loco Dras (in via Ladak, Kashmir) die 28 augusti 1940; typus positus in Herb. Crypt. Ind. Orient. New Delhi.

Ovaricolous. Sori up to 1 cm. long, 5–8 mm. broad, at first enclosed by a firm false membrane, later dehiscing at apex exposing "auburn" coloured spore masses; columella prominent, protruding out of the sorus, forked at tip. Spores forming loose spore balls, soon disintegrating and then pulverulent; spores "snuff brown" (Ridgway), globose, subglobose, or ellipsoidal, some slightly angular, 7.4 to 13.0 μ in diameter with a mean of 10.4 μ; epispore comparatively less thick, surface minutely but prominently pitted; germinating by means of a septate promycelium with terminal and lateral sporidia.

On ***Pennisetum flaccidum* Griseb. Baltistan (Kashmir, 9000 ft.), Aug. 16, 1940, *No. 20793* (Type); Ladak road (Kashmir, 9000 ft.), Aug. 28, 1940, *No. 21146.* Type deposited in Herb. Crypt. Ind. Orient.

11. *CINTRACTIA ELYNAE Sydow, Ann. Myc. **22**: 289. 1924.
Syn. *Cintractia hyperborea* Ciferri, Ann. Myc. **29**: 64. 1931.
Cintractia chinesis Yen, Contr. Inst. Bot. Nat. Acad. Peiping **3**: 41. 1937.

In ovaries of ** *Kobresia capillifolia* C. B. Clarke, at Burzil Chowki (Kashmir, 12,000 ft.), July 28, 1940, *No. 19991.* The host of Sydow's (**1924**) fungus is *Elyna spicate* Schrad. = *Elyna*

Bellardii Koch, = *Kobresia scirpina* Willd. Ciferri gives the host of his fungus as *Kobresia Bellardi* and Yen (**1935**) as *Kobresia scirpina* Willd. Measurements of spores given by Sydow are 14–20 μ, by Ciferri, 16 to 24 μ and by Yen, 15 to 20.4 μ. The measurements of the spores in the present collection are 15.8 to 22.4 μ.

12. ***Cintractia Kobresiae** Mundkur, sp. nov.

Ovaricola; sori emergunt ex glumis ut corpora nigra, globosa, valde firma; columella nec emergens nec prominens. Sporarum massae primo coopertae albo operculo, quod cito degenerat, sed sporae simul aggluninatae et dirmiter tentae, raro pulverulentae. Sporae ovatas, irregulariter ellipsoideae, planae, nonnulae obtuse anglulares, coloure "Saccardo's umber" (Ridgway), diam. 12.1–17.7 μ, medietate 15.4 μ; epispora crassa, superficie minute echinulate; germinat per septatum promycelium lateralibus atque terminalibus sporidiis ornatum.

Typus lectus a R. R. Stewart (*No. 20357*) in loco Satpura, in rivo super Skardu, Kashmir in ovariis *Kobresiae laxae* Boeck. atque positus in Herb. Crypt. Ind. Orient.

Ovaricolous. Sori protruding out of the glumes as globose, black bodies, very firm; columella not protruding out or prominent. Spore masses at first covered by whitish covering soon wearing away but spores sticking together and firmly held, rarely powdery. Spores oval, irregularly ellipsoidal, flat, several bluntly angled, "Saccardo's umber" (Ridgway), 12.1 to 17.7 μ in diameter with a mean of 15.4 μ; epispore thick, surface minutely echinulate; germinating by means of a septate promycelium with lateral and terminal sporidia.

In ovaries of ***Kobresia laxa* Boeck. at Satpura-nulla, above Skardu (Kashmir), Aug. 3, 1940, *No. 20357* (Type). Type deposited in *Herb. Crypt. Ind. Orient.*

13. CINTRACTIA CARICIS (Pers.) Magnus, Verh. Bot. Ver. Prov. Brandenb. **37**: 79. 1895.

Syn. *Uredo Caricis* Pers. Syn. Meth. Fung. p. 225. 1801.

On ***Carex cardiolepis* Nees, Sonamarg (Kashmir, 10,000 ft.), 25–7–1921, *No. 6409;* [this host is recorded as *Carex* sp. by Clinton and Zundel (1938)].

PERICLADIUM Pass. Nuovo Giorn. Bot. Ital. **7**: 185. 1875. Emend. Mundkur.

Syn. *Xylosorium* Zundel, Mycologia **31**: 576. 1939.

Sori as oval pustules on stems, 2–4 locular, enclosed by a hard, coriaceous membrane rupturing irregularly at maturity, disclosing dark-brown, semi-agglutinated spore masses; spores at first as spore balls, disintegrating into single spores at maturity.

TYPE SPECIES: *Pericladium Grewiae* Passerini on *Grewia* (*mollis* Tues?) Abyssinia, leg. Beccari; the genus was placed by Passerini in the Uredinales but generic description has been emended and the genus transferred to Ustilaginaceae.

14. *PERICLADIUM GREWIAE Pass.

Syn. *Ustilago Grewiae* (Pass.) Henn. Hedwigia **39**: 75. 1900.

Petioles and branches covered by usually crowding, often coalescing, almost globose or sometimes angular, cinnamon brown, pustules, appearing like mustard seed, and enclosed by a coriaceous, hard, and woody covering; pustules 1–2 mm. in diameter, opening irregularly at apex forming a long crack, showing 2 or 3 locules, and a black powdery spore-mass. Spores nearly globose or ellipsoid, often somewhat angular, "buffy brown" (Ridgway), 5.6–8.6 μ in diameter with a mean of 7.8 μ; epispore thick, smooth; germinating by means of a septate promycelium forming terminal and lateral sporidia.

On petioles and stem of** *Grewia villosa* Willd. Kala Chitta Hills (Attock Dist.), April 1934, *No. 13611* (FIG. 1).

15. SOROSPORIUM REILIANUM (Kuehn) McAlpine, Smuts of Australia, p. 181. 1900.

On *Sorghum halepense* Pers. Lower Sind Valley (Kashmir, 5500 ft.), Sept. 3, 1940.

TILLETIACEAE

16. *UROCYSTIS COLCHICI (Schl.) Rab. Fungi Europei *396*. 1861.

On **Colchicum luteum* Baker, Abbottabad (N.W.F.P., 4000 ft.), April 1935, *No. 14616*.

17. UROCYSTIS STIPAE McAlpine, Smuts of Australia, p. 198. 1910.

On *Stipa sibirica* Lamk. Sonamarg, Sind valley (Kashmir, 9000 ft.), Aug. 31, 1940, *No. 21286*.

18. UROCYSTIS TRITICI Körn. Hedwigia **16**: 33. 1877.

On *Triticum vulgare* Host, Topi Park, (Rawalpindi, Punjab.), Apr. 29, 1924.

SUMMARY

Twenty-one collections of smuts made by Dr. R. R. Stewart and Mrs. I. D. Stewart in North Western India have been investigated. Of these *Ustilago Cordai*, *Ustilago reticulata*, *Cintractia Elynae*, *Pericladium Grewiae* and *Urocystis Colchici* are new records for India. Two smuts, *Sphacelotheca Stewartii* and *Cintractia Kohresiae*, are proposed as new species. The smut on *Grewia* which was placed in the genus *Ustilago* by Hennings has been restored back to the genus *Pericladium* proposed by Passerini for its reception and the genus itself has been transferred from the Uredinales to the Ustilaginales. Zundel's genus *Xylosorium* has been shown to be a synonym of *Pericladium* and his *Xylosorium Piperii* is proposed as *Pericladium Piperii* (Zundel).

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Sydow, H. Notizen über Ustilagineen. Ann. Myc. **22**: 289. 1924.

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AN UNDESCRIBED CORTICIUM WITH CONIDIA

C. L. SHEAR[1] AND ROSS W. DAVIDSON[1]

(WITH 2 FIGURES)

In March 1942 the senior author found on the bark of a decaying oak stump at Weikiwa Springs, Florida, a reddish-brown hyphomycete suggesting in general appearance forms that have been referred to *Ptychogaster* and *Ceriomyces*, some of which have been found associated with polypores (**2**). A microscopic examination showed an abundance of subglobose brown conidia. A careful examination about the margins and beneath the conidial layer revealed a thin, effuse, dingy gray hymenium that proved to be a species of *Corticium*. Single basidiospore cultures produced an abundant growth of the same conidial fungus that was associated with the *Corticium*. Microscopic examination shows that this conidial stage is very similar in character to some species that have been referred to *Sporotrichum* and *Rhinotrichum* rather than *Ptychogaster* or *Ceriomyces*.

Conidia have been described for four species of *Corticium: C. alutaceum* (Schrad.) Bres. (**4**), *C. roseo-pallens* Burt (**1**), *C. effuscatum* Cooke & Ellis (**4**, **5**) and *C. vagum* Berk. & Curt. (**3**, p. 203; **7**). Our fungus does not agree with any of these species either in the basidial or conidial form. A specimen was submitted to Dr. H. S. Jackson who is making a special study of *Corticium*. He reports that he knows of no species having such a conidial stage or agreeing with the basidial form. He suggests that if *Aleurodiscus* is to be treated as distinct from *Corticium* our plant might be referred to that genus. It seems best for the present to place it in *Corticium*. Therefore, it is described as a new species of that genus.

[1] Respectively, Collaborator, Division of Mycology and Disease Survey, and Associate Mycologist, Division of Forest Pathology, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

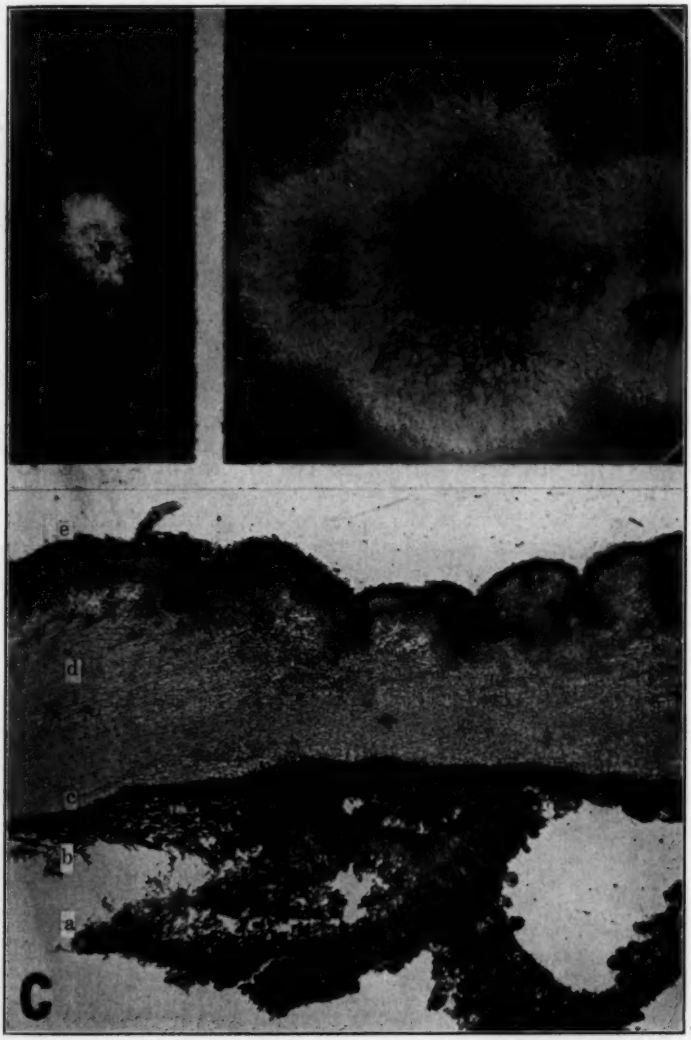

FIG. 1. *Corticium conigenum*. *A* and *B*, 8-day-old cultures. *A*, a slow growing haploid culture developed from a single basidiospore; *B*, a diploid culture showing dark mass of conidia in center of mat. *C*, photomicrograph of a section through basidial fructification: *a*, substratum; *b*, loose brown hyphae; *c*, compact narrow brown layer; *d*, dense thick layer of hyaline hyphae; *e*, hymenium.

Corticium conigenum sp. nov. (FIGS. 1, *A–C;* 2, *A–F*)

Fruiting layer effuse resupinate, several cm. broad, adhering to rough surface of bark, becoming dark gray to black or "fuscous"[2] to "black," surface pruinose, irregularly areolate; substance waxy, margin not conspicuous, varying in thickness from 300 to 700 μ, base composed of dark brown loosely interwoven hyphae and a thin compact layer of dark hyphae above which is a hyaline or slightly colored dense layer upon which appear areolate pulvinae that support the basidia; basidial layer dark at surface with numerous brown conidia and short segments of brown irregular hyphae (paraphyses?) and crystalline matter embedded; basidia 4-spored, hyaline, elongate; basidiospores hyaline, smooth, ovoid, 6–7 × 4–5 μ.

Conidial layer loose floccose, powdery, "carob brown" or "burnt umber" (in culture when young light pink, soon becoming darker, "cameo brown" or "vinaceous-brown"); hyphae thin-walled, hyaline (in culture), much branched and with numerous septae and clamps, mycelium in pure cultures soon colored by masses of conidia; conidia brown, loosely catenulate, irregular or globose to oval in shape, slightly roughened, 4 to 6 μ in diameter, produced in great abundance on short terminal and lateral sporophores.

Fructificationes resupinatae, ceraceae, superficie pruinosa et irregulariter areolata, fuscae, 300–700 μ crassae, primum strato conidico vinaceo, floccoso, pulverulento tectae; basidiis 4-sporis; sporis ovoideis, glabris, 6–7 × 4–5 μ; conidiis globosis vel ovoideis, brunneis, 4–6 μ in diam.

On: stump of *Quercus* sp., Weikiwa Spa, Fla., March 10, 1942, C. L. Shear, *No. 1405*. Type specimen in the Mycological Collections of the Bureau of Plant Industry, Soils, and Agricultural Engineering.

PURE CULTURE STUDIES

Conidia from the original specimen germinated within 16 hours when placed on cornmeal agar. All cultures from single conidia contained numerous clamp connections after two days growth and developed an abundance of conidia in 2 or 3 days.

Basidiospores were obtained by placing a small moistened section from the hymenium over a petri dish containing cornmeal agar. After about 18 hours in such a moist condition basidiospores were produced so abundantly that many cultures could

[2] Colors in quotation marks refer to Ridgway (6).

be obtained by slowly passing the segment of hymenium across the surface of the agar medium. The basidiospores germinated in about 6 hours after being deposited.

Single basidiospore cultures developed no clamp connections and grew only 1/2 to 2/3 as fast as the cultures from single conidia. They developed an abundance of conidia and in general appearance were similar to the cultures from conidia. Ten single basidiospore cultures were obtained and grown together in all possible

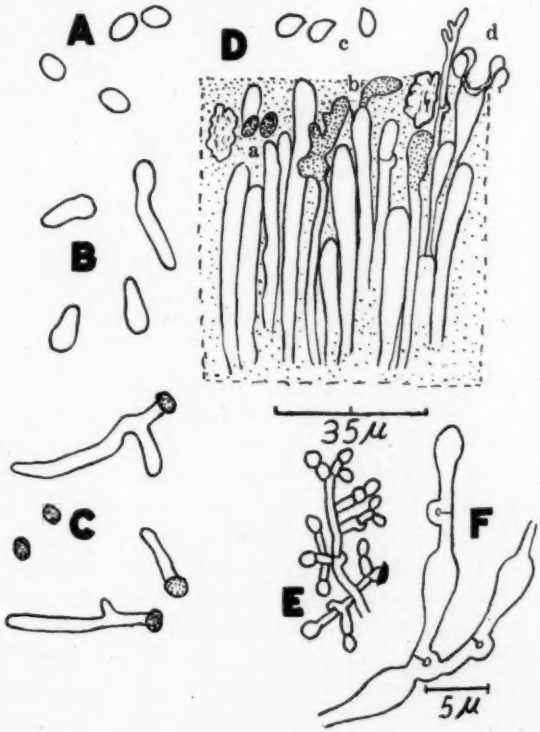

FIG. 2. *A–E, Corticium conigenum.* *A* and *B*, camera lucida outline drawing of basidiospores after 14 hours on cornmeal agar; *C*, germinating conidia from diploid mycelium; *D*, reconstructed section through hymenium, drawn with the aid of a camera lucida: *a*, embedded conidia; *b*, dark hyphae (paraphyses?); *c*, basidiospores; *d*, basidium; *E*, sketch of conidia developing on young hyphae; *F*, highly magnified hypha showing development of conidia.

combinations. They were found to consist of two sex strains—three of one strain and seven of the other (Table 1). Clamp connections developed where mycelium from any of the three came in contact with mycelium of any of the other seven. No clamps were formed from crosses within these two groups.

There was considerable difference in growth rate and conidial development of the ten single basidiospore cultures, but there

TABLE 1

TEN SINGLE BASIDIOSPORE CULTURES OF *Corticium conigenum* SHOWING ALL POSSIBLE CROSSES

Culture numbers	1	2	3	4	5	6	7	8	9	10
1	−[2]	−	+	−	+	−	+	−	−	−
2	−	−	+	−	+	−	+	−	−	−
3	+	+	−	+	−	+	−	+	+	+
4	−	−	+	−	+	−	+	−	−	−
5	+	+	−	+	−	+	−	+	+	+
6	−	−	+	−	+	−	+	−	−	−
7	+	+	−	+	−	+	−	+	+	+
8	−	−	+	−	+	−	+	−	−	−
9	−	−	+	−	+	−	+	−	−	−
10	−	−	+	−	+	−	+	−	−	−

[2] − indicates no clamp connections formed and + indicates presence of clamp connections.

was no consistent visible difference between cultures from the two sex strains. It was impossible to determine the presence or absence of clamp connections except by a microscopic examination of mycelium from along the line where two cultures had grown together. Rate of growth for the single basidiospore cultures[3] was quite variable. The slowest growing one was No. 6 (FIG. 1, *A*), which made a diameter growth of 22 mm. in 7 days at room temperature of 24° C. and the fastest was No. 10 with 54 mm. diameter growth. Most of the cultures developed such an abundance of conidia that the mycelial mats soon became "vinaceous-brown" although the mycelium itself is white (FIG. 1, *B*).

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[3] Except for spore germination work, all tests with cultures of this fungus were on 2½ per cent malt agar and in a room temperature of about 24° C.

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TWO AMERICAN HARDWOOD SPECIES OF ENDOCONIDIOPHORA DESCRIBED AS NEW

ROSS W. DAVIDSON[1]

(WITH 2 FIGURES)

A fungus recorded as *Endoconidiophora coerulescens* Münch was found by Davidson (**2**) and Verrall (**6**) to be one of the most important fungi causing stain of hardwood logs and lumber in the South. During the earlier study (**2**) it was not observed on pine logs or lumber even where both pine and hardwood logs were handled by the same mill. Verrall (**6**) isolated it twice from pine wood but found it prevalent and important only on hardwoods. In Europe Münch (**5**) illustrated *E. coerulescens* on pine wood, and Lagerberg, Lundberg, and Melin (**3**) isolated it only from stained spruce and pine. A further reason for differentiating the pine- and spruce-inhabiting *E. coerulescens* of Europe from the fungus found on American hardwoods by Verrall and the author is the fact that the latter does not produce the amyl-acetate odor, which is characteristic of *E. coerulescens* Münch (**3**).

Cultures of the European fungus were obtained from the Centraalbureau Voor Schimmelcultures and compared with isolates of the American fungus. These comparisons show that although the two are quite similar morphologically there are several consistent and significant differences. Therefore, the hardwood lumber fungus is described here as a new species.

The second species described in this paper produces a banana-oil odor but differs morphologically from *E. coerulescens* and other described species. It was isolated from chestnut oak bark.

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Endoconidiophora virescens sp. nov.[2] (FIG. 1, *B* and *C*)

Mycelium forming gray to black fluffy growth over sapwood on ends of recently cut logs and on surface of green lumber; perithecia abundant and conspicuous as black dots on surface of wood, forming in 4 to 7 days after infection; in culture black, 150–250 μ diameter frequently slightly higher than wide, covered with numerous long narrow black hyphae; beaks variable in length averaging 800 μ long, 35 μ wide at base to 14 μ at tip, smooth, black, with hyaline fringe of pointed hyphae around ostiole 25 $\times$ 1.5 μ; ascospores collecting in sticky white sphaerical mass at tip of beak, frequently arranged in bundles, 5.5–7.5 μ $\times$ 1.7–2 μ, slightly curved, hyaline; conidiophores brown, of two types, one long and enlarged slightly in middle but tapering to the hyaline to light brown tip, about 150 μ long by 5 μ at base to 2.2–3.5 μ at tip and bearing long cylindrical microconidia, other darker brown up to about 120 μ long enlarged slightly to the tip, 5–6 μ at base to 6.5 μ at tip and bearing chains of short barrel-shaped conidia; all conidia are formed endogenously, microconidia hyaline, cylindrical, in moniliform chains, variable in length, 6–25 μ $\times$ 2–3 μ, short barrel-shaped endoconidia 5–9 μ $\times$ 5–6.5 μ growth on malt agar rapid, about 45 mm. radial growth in 5 days, mycelium coarse, dark greenish gray, with musty penetrating odor.

On green sapwood of hardwood logs and lumber: *Liquidambar styraciflua* L., *Liriodendron tulipifera* L., *Nyssa aquatica* L., *Fagus grandifolia* Ehrh., *Magnolia* spp., and *Quercus* spp. common in Southern States from Virginia to Florida and Louisiana. Isolated twice from pine lumber (6). Type, For. Path. *94161*, from *Lirioderdron tulipifera*, in Myc. Coll. Bur. Plant Industry, Soils, and Agricultural Engineering.

Mycelium griseum vel atrum; perithecia in superficie ligni abundantia et conspicua, in culturis atra, 150–250 μ in diam., hyphis longis angustis atris tecta; rostra longitudine variabilia, plerumque 800 μ longa, basi 35 μ apice 14 μ crassa, levia, atra, e ciliis acuminatis hyalinis ostiolaribus 25 μ longis 1,5 μ latis fimbriata; ascosporae in massam glutinosum albam sphericam ad apicem rostri agglutinatae, saepe fasciculatae, 5.5–7.5 μ longae, 1.7–2 μ latae, subcurvatae, hyalinae; conidiophora brunnea, generum duorum, conidiis omnibus endogenis: altera longa, in medio subinflata, apicem hyalinum vel pallide brunneum versus attenuata, circa 150 μ longa, basi 5 μ apice 2.2–3.5 μ lata, microconidia hyalina cylindrica, 6–25 μ longa, 2–3 μ lata, in catenulis moniliformibus ferentia; altera obscuriore brunnea, usque 120 μ longa, apicem versus

[2] The Latin descriptions were prepared by Edith K. Cash, Assistant Mycologist, Division of Mycology and Disease Survey, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture.

leniter inflata, basi 5–6 μ apice 6.5 μ crassa, catenulas conidiorum breviorium dolabriformium 5–9 μ longorum 4–6.5 μ latorum ferentia.

In general growth and morphological features this fungus is very similar to *Endoconidiophora coerulescens* Münch, but the European species is reported by Lagerberg et al (**3**) to be a spruce fungus but growing also on pine. *E. coerulescens* forms a banana-oil (amyl-acetate) odor whereas the American hardwood

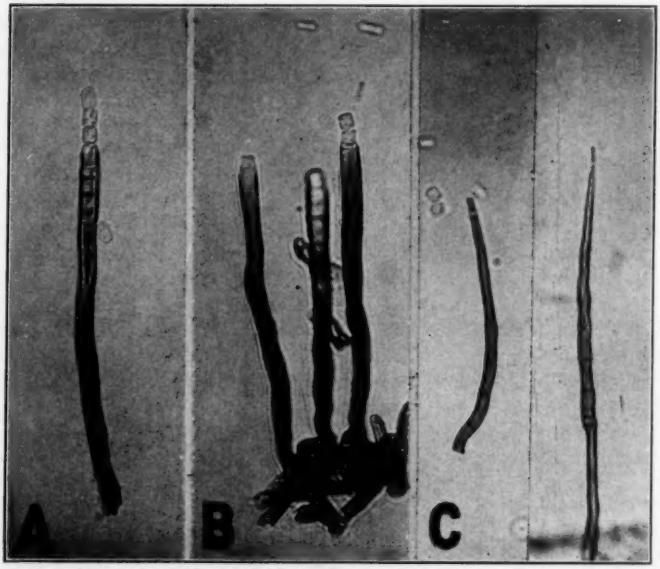

FIG. 1. *A*, typical conidiophore and endoconidia of *Endoconidiophora coerulescens* Münch; *B*, wide-mouthed conidiophores of *Endoconidiophora virescens; C*, small-mouthed conidiophores, with endoconidia attached, of *E. virescens*.

fungus develops a distinctive musty odor on lumber and in culture. There is also a difference in conidia and conidiophores. The conidiophores in the European fungus are stated to be 3.7 to 8.4 μ at the tip (FIG. 1, *A*) while those of *E. virescens* are of two types with the smaller diameter one 2.2 to 3.5 μ at the tip. None of the conidiophores described or illustrated by Lagerberg et al (**3**) and Münch (**5**) are of this small type. No conidiophores of the smaller tapering type were observed in the two *E. coerulescens*

cultures studied by the writer. The conidia of *E. coerulescens* are reported (**3**) to vary greatly and such variation is illustrated (**3**, figure 24, *C*). This same illustration also shows the two types of conidia, that is, long cylindrical and short barrel-shaped, but no measurements are given below 4 μ and 5 μ diameter by Münch (**5**), and Lagerberg et al (**3**) gives 5 μ as the smallest for the cylindrical type. The cultures examined by the writer showed the same wide variation in conidial size but the smallest diameter observed was 3 μ with an average of about 4 μ for the cylindrical type, and as near as could be determined both cylindrical and barrel-shaped spores were produced from similar types of conidiophores.

According to the description of growth in pure culture (**3**) the American and European fungi are about the same. Both grow rapidly when first isolated and have a radially arranged, coarse, very dark gray-green mycelium. Older cultures of the American hardwood fungus are often quite variable in growth rate and may lose their ability to form perithecia. In such cultures the mycelial mat is usually of a lighter gray and fluffy type as contrasted with the radial gray-green growth of fresh cultures. Occasionally sectoring occurs and both types of growth are present, with perithecia confined mostly to the apparently normal segment. Several old cultures have failed to make a rapid radial growth. In such cases the mycelium is appressed and submerged and irregular in outline; conidia are abundant but perithecia are absent or develop only very slowly.

In older abnormal cultures odor may be absent or not very distinct.

The European cultures studied were slower growing and of a more velvety appressed type of mat, and perithecia developed very slowly. Conidia and conidiophores were exceedingly abundant. According to Lagerberg et al (**3**) this slower appressed growth is not normal for recent isolates. Odor was of the distinct banana-oil type.

Endoconidiophora variospora sp. nov. (FIG. 2, *A–E*)

Forming a gray mold over surface of inner or cambium side of freshly peeled bark; perithecia not conspicuous, flask-shaped,

rather delicate, with base sphaerical to somewhat flattened and partially embedded, often collapsed, 150–250 μ diam., light brown to black; beaks black, 600–1200 μ long by 25–35 μ thick at base to 12–17 μ at ostiole, erect, sharp-pointed bristles around ostiole, ascospores collecting in a light brown sticky mass at tip of beak, hyaline, ovoid, with disk-shaped membrane on one side, 4.5–6 μ × 2–3.5 μ; endoconidiophores light brown to hyaline, of two types, one tapering to small diameter at tip and bearing cylindrical endoconidia, 50–80 μ × 2.5–4 μ, the other light brown, several septate, short 20–50 μ long, slightly enlarged to tip, 4–5 μ diam. at base to 5–7 μ at tip; endoconidia in chains, of two types, cylindrical, hyaline, to light brown, 6–15 μ × 2–4 μ, and short barrel-shaped, 4–8 μ × 4–6.5 μ, often becoming globose.

Cultures white, often developing gray to brown patches, conidiophores mostly longer, 70–120 μ, often branched, tapering to tip, bearing cylindrical endoconidia, hyaline or light brown (black in mass); exogenous macroconidia abundant, borne on short narrow conidiophores, brown, 10–14 μ × 8–10 μ; perithecia few or absent; 15 mm. radial growth in 5 days; odor similar to banana oil.

Perithecia inconspicua, lageniformia, tenella, basi rotundato vel subapplanato et partim immerso, saepe collapsa, 150–250 μ in diam., ex pallide brunnea atra; rostra atra, 600–1200 μ longa, basi 25–35 μ apice 12–17 μ crassa, ciliis rectis acuminatis ostiolaribus praedita; ascosporae in massam pallide brunneam mucosam ad apicem rostri agglutinatae, hyalinae, ovoideae, uno latere membrana disciformi ornatae, 4.5–6 μ longae, 2–3.5 μ latae; endoconidiophora pallide brunnea vel hyalina, generum duorum: altera ad apicem angustum attenuata, 50–80 μ longa, 2.5–4 μ lata, endoconidia cylindrica ferentia; altera pluriseptata, brevia, 20–50 μ longa, basi 4–5 μ apice 5–7 μ crassa; endoconidia catenulata, dimorpha; altera cylindrica, hyalina usque pallide brunnea, 6–15 μ longa, 2–4 μ lata; altera breve dolabriformia, 4–8 μ longa, 4–6.5 μ lata, saepe globosa. In culturis conidiophora plerumque longioria, 70–120 μ, saepe ramosa; macroconidia exogena abundantia, brunnea, 10–14 μ longa, 8–10 μ lata, in conidiophoris brevibus angustis oriundia; perithecia pauca vel mulla.

On cambium side of chestnut oak (*Quercus montana* Willd.) tanbark one week after it was removed from a living tree. Collected by Marvin E. Fowler near Moorefield, West Virginia, May 1943. Type *94257* in Myc. Coll. Bur. Plant Industry, Soils, and Agricultural Engineering.

This species is similar to *Endoconidiophora moniliformis* (Hedg.) Davidson (**2**) in ascospore character and in odor but has perithecial and conidial differences. The large brown macroconidia produced abundantly in cultures are similar to those of *Chalarop-*

sis thielavioides Peyronel (**4**) and *Ceratostomella* (*Endoconidiophora*) *radicicola* Bliss (**1**). It is most closely related to the latter species but differs in shape and size of ascospores, growth

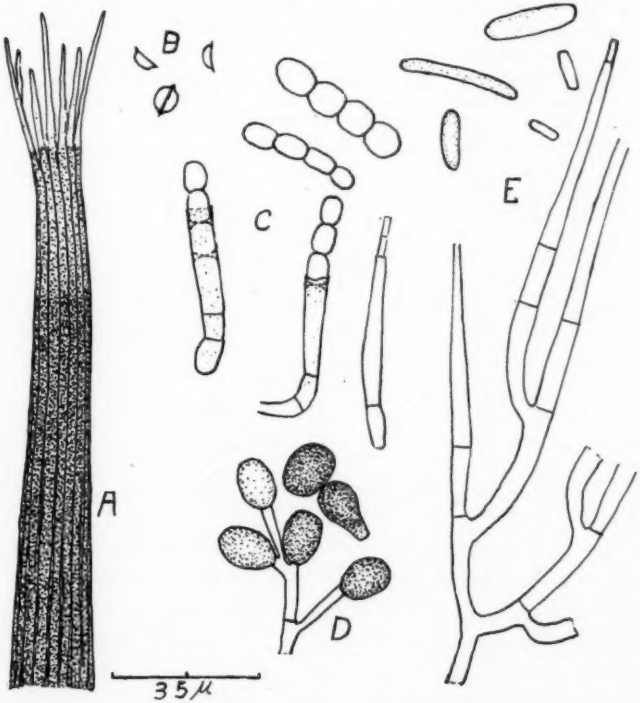

FIG. 2. *A–E, Endoconidiophora variospora. A*, tip of perithecial beak; *B*, ascospores; *C*, conidiophores and endoconidia from chestnut bark; *D*, exogenous macroconidia developed in culture; *E*, conidiophores and endoconidia from a culture.

rate, and color of mycelium. The short broad type of endoconidia were not described for *C. radicicola* and the type of odor produced was not recorded.

SUMMARY

The common American hardwood staining species of *Endoconidiophora* previously referred to *E. coerulescens* Münch, a conifer fungus, is shown to be a distinct species and described as

E. virescens. Another related species causing gray mold on chestnut oak tanbark is described under the name *E. variospora*.

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NOTES AND BRIEF ARTICLES

Fungi for Penicillin Production

A project is being organized at the University of Minnesota Agricultural Experiment Station, Division of Plant Pathology on Botany, to survey Penicillia belonging to the *Penicillium notatum* group and also species of *Aspergillus* for the production of penicillin. The project is under the supervision of Dr. E. C. Stakman. Cultures of organisms are desired, and individuals are requested to forward isolations of the groups of fungi mentioned to the laboratory indicated. Isolations known to produce penicillin are especially desired.

Individuals who wish to survey other fungi for penicillin activity can obtain directions for a standard technique from the United States Department of Agriculture, Regional Laboratory at Peoria, Illinois.—Albert L. Elder, War Production Board, Coördinator of Penicillin Program.

Odontia Archeri (Berk.) Wakefield

This large and handsome resupinate was collected more than once during January and February, 1944, on the sides of corticated logs of loblolly pine in low, dense woods near Gainesville, Fla. Being entirely new to me, I sent it to Dr. Linder, at Harvard, for determination. "I am glad," he said, "to have this specimen since it is the first collection of the species that we have from the United States, and furthermore it is better developed than the other ones we have, which came from the tropics." The hymenium is flavous when young, becoming melleous when mature, and the colors are well preserved in dried specimens.—W. A. Murrill.

Sir Edwin Butler, 1874–1943

A recent letter from Professor F. T. Brooks of Cambridge University tells of the death in April, 1943, of Sir Edwin Butler, Kt., C.M.G., C.I.E., F.R.S., D.Sc., LL.D., M.B.

To the student of Aquatic Phycomycetes Sir Edwin's name is forever linked with that classic, "An Account of the Genus *Pythium* and some Chytridiaceae," as well as with other outstanding papers in the group, one establishing the remarkable genus *Allomyces*. To one who also had the high privilege of knowing and of having frequent contacts with him in his capacity as Director of the Imperial Mycological Institute at Kew, and as Lowell Lecturer in Boston in 1932, his name is linked, as well, with a genial, cordial and hospitable Irish gentleman.—F. K. SPARROW, JR.

Corrections in the article "The genera *Trechispora* and *Galzinia* (Thelephoraceae)," published in Mycologia **36**: 70–103. 1944.

Page 70, 1st paragraph, line 8: a period should be inserted after "*Brinkmanni.*"

p. 77, l. 7: for "p. 73" read "p. 99"; in the footnote (l. 23) for "*Episthele*" read "*Epithele.*"

p. 87, l. 27: for "*I. coronifera*" read "*T. coronifera.*"

p. 99, l. 14: for "p. 80" read "p. 77."

DONALD P. ROGERS

A NEW RUSSULA SPORE

On a February afternoon I was picking my way through small shrubs in a piece of open flatwoods and admiring the first flowers of *Viola septemloba* when I happened upon a small reddish russula with pink stem and pure-white gills. At first I was inclined to ignore it in favor of the handsome violets but picked it on principle and took it to my desk at the University. Little did I realize what a surprise was in store for me. On casually examining the spores under a microscope I decided I had a parasite, or something, and began to look around for the real spores. Then I made a good mount and stained it, and there were these same peculiar spores on basidia on a bit of the gill!

Russula spores as a rule, as mycologists very well know, are rounded, more or less aculeate, and amyloid. Beardslee discovered a notable exception in his *R. heterospora* with smooth, oblong spores, but this one species has remained so far as I know

the only exception to the general rule in this large genus. This new type I have just found is very different from the one Beardslee described. In shape and size the spores are similar to those found in many species of *Tricholoma*, being narrow, inequilateral, and obliquely apiculate at the base. But they are amyloid and characteristically aculeate. Who would have expected an innocent-looking little red russula to turn out to be such a brazen nonconformist!

Russula novispora sp. nov.

Pileo convexo-subdepresso, 3 cm. lato, glabro, roseo, non grato; lamellis adnatis, latis, albis; sporis subellipsoideis, aculeatis, albis, 8 × 5 μ; cystidiis fusiformibus; stipite glabro, subincarnato, 1.5 × 0.6–0.8 cm.

Pileus convex to slightly depressed, solitary, 3 cm. broad; surface slightly viscid, smooth, glabrous, deep-roseous, darker at the center, margin even, entire; context white, unchanging, 5 mm. thick near the disk, odorless, very astringent and slightly acrid; lamellae adnate, few inserted, not forked, ventricose, rather broad, close, entire, white; spores chalk-white in mass, elongate subellipsoid, inequilateral, obliquely apiculate, sparsely but distinctly echinulate, about 8 × 5 μ; sterile cells abundant, sharp, hyaline, projecting 15–25 μ; stipe tapering downward, smooth, glabrous, pale-incarnate, unchanging, 1.5 × 0.6–0.8 cm.

Type collected by W. A. Murrill in rather moist open slash-pine flatwoods just east of Gainesville, Fla., Feb. 11, 1944 (*F 17994*). Distinguished at once by its unusual spores, of a type hitherto unknown to me in the genus. They are shaped like those of many species of *Melanoleuca*, *M. equestris*, for example. The dried cap resembles in color the dark form of *R. amethystina* Quél. but is not umbonate.—W. A. MURRILL.

RESISTANT SPORANGIA ON SEXUAL PLANTS OF ALLOMYCES ARBUSCULUS

It was on December 15, 1933, that the writer first noticed resistant sporangia on sexual plants. In April, 1934, Emerson "discovered numerous resistant sporangia borne on sexual plants of *A. arbusculus* var. *minor*—. Since that time they have frequently been found (by Emerson)—in agar as well as older water cultures of a majority of the isolates of both *A. arbusculus* and

A. javanicus." [1] . . . "Sörgel (1937) also observed the formation of resistant sporangia on hyphae bearing gametangia in the strains of *A. arbusculus* which he studied." [1]

"Hatch (1935) said that sexual mycelia could be derived from isolations of zoöspores from resting (resistant) sporangia formed on sexual mycelia, but he gave no experimental evidence in support of this statement." [1]

The evidence to substantiate my 1935 statement, referred to in the paragraph above, is submitted herewith.

Camera lucida drawings, made in December 1933, at the time of the writer's original observations, show the various positions taken by the resistant sporangia on the plant. Sometimes the resistant sporangia were subtended by male gametangia. In other instances the resistant sporangia appeared on sympodial branches that grew around couplets of male and female gametangia. The resistant sporangia sometimes terminated the growth of the hypha, but in most cases the growth of the hypha was continued past the resistant sporangia by sympodial branching. On certain hyphae these sympodial branches again produced pairs or chains of gametangia.

Upon the plant on which this initial study was made the resistant sporangia were numerous—almost as numerous as upon the asexual plant. The plant in question was grown on a maltose-peptone agar plate, the resistant sporangia appearing late in the history of the culture as the agar began to dry.

The nature of the products derived from these resistant sporangia was determined by drying the resistant sporangia 18 days and inoculating them into sterile distilled water to which hemp seed had been added. The zoöspores from these resistant sporangia germinated to form sexual plants which were normal in all observable respects. Three days after the resistant sporangia had been introduced into the baited water cultures the new plants could be definitely identified as sexual because of the characteristic pigmentation of the male gametangia. While no camera lucida drawings were made of these plants, camera lucida drawings were made of certain sexual plants that had developed from zoöspores that had been discharged from

[1] Emerson, 1941.

one of the resistant sporangia on the original plant—the plant on which the resistant sporangia were first observed. The resistant sporangium in question had dehisced in the agar, producing zoöspores and in turn sexual plants.

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